SCIENCE

NEW SERIES
VOL. LXX, No. 1805

FRIDAY, AUGUST 2, 1929

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

SCIENCE

VOL. LXX FRIDAY, AUGUST 2, 1929 No. 1805

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.
Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE INTERNATIONAL RELATIONSHIP OF MINERALS[1]

By Sir THOMAS HOLLAND

RECTOR OF THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON, PREVIOUSLY PROFESSOR OF GEOLOGY AND MINERALOGY IN THE UNIVERSITY OF MANCHESTER

A FEW years ago members of this association looked forward annually to a generalized statement of the results of their president's own research work in science. The rapid specialization of science, with its consequent terminology, has, however, made it increasingly more difficult in recent years for any worker to express himself to his fellow-members.

Last year at Glasgow most of us expected that the hidden secrets of crystals would be revealed by one whose capacity for popular exposition accompanies a recognized power for extending the boundaries of science. Instead, Sir William Bragg released his store of accumulated thought on the relationship of science to craftsmanship in a way which gave each specialized worker an opportunity to adjust his sense of relativity and proportion.

If I attempted now to summarize my scattered ideas on the outstanding problems of micropetrology, I might possibly find half-a-dozen members charitably disposed to listen, and of them perhaps one might partly agree with my theoretical speculations. We have indeed to admit that the science of petrology, which vitalized geological thought at the end of the last century, has since passed into the chrysalid stage, but, we hope, only to emerge as a more perfect imago in the near future.

Coincident with the excessive degree of specialization which has developed with embarrassing rapidity within the present century, the problems of the great

[1] Address of the president of the British Association for the Advancement of Science, Cape Town, South Africa, July 31, 1929.

war drew scientific workers from their laboratories and forced them to face problems of applied science of wider human interest. And the atmosphere of this great mining field[2] stirs ideas of this wider sort—ideas concerning a field of human activity which, in recent years, has affected the course of civilized evolution more profoundly than seems to be recognized even by students of mineral economics. This must be my excuse for inviting you to consider the special ways in which the trend of mineral exploitation since the war has placed a new meaning on our international relationships.

With knowledge of the shortcomings which were felt during the war, in variety as well as quantity of metals, it was natural immediately after to review our resources with the object in view of obtaining security for the future. But events have since developed rapidly, both in international relationships and in mineral technology. The evolution of metallurgy during the present century and the developments in mining on which metallurgy depends have placed new and rigid limitations on a nation's ability to undertake and maintain a war; consequently, the control of the mineral industries may be made an insurance for peace. Let us first consider briefly how these circumstances have arisen, how each country has passed from the stage of being self-contained in variety of essential products to the most recent of all developments, the change to large-scale production that has tended to the concentration of the mineral and metal industries to certain specially favored regions which will hold the position of dominance for several generations to come.

The names of Isis, Cybele, Demeter and Ceres seem to suggest that the ancient theologians in different lands formed the same conception of those peculiar conditions in prehistoric times which made it likely that a woman—tied for long periods to the home-cave—rather than a man, was the one who first discovered the possibility of raising grain-crops by sowing seed. Whoever it was who first made this discovery was the one who diverted the evolution of man along an entirely new branch, and so laid the foundation on which our civilization was subsequently built—the beginning of what Rousseau called "Le premier et plus respectable de tous les arts."

Compared with this economic application of observational science, the later inventions, which seem so important to us—explosives, printing, the steam engine—were but minor incidents in the evolution of civilized activities. Previous uncertainty regarding the supply of the products of the chase, and the dangers which were necessarily attached to the collection of berries and edible roots in the jungle, became less important to the family-man when it was found possible to raise food-supplies nearer home. This discovery was thus not one of merely material advantage, for it necessarily led to the idea of storage and so opened up a new mental outlook for primitive man.

But then this new possession of field-crops—the acquisition of cultivated real estate—created fresh cares and new anxieties which contained the germ of future political problems. In addition to the previous dangers from nomadic hunters and predatory carnivora, new troubles arose from other enemies—herbivorous animals, birds, insects, droughts and floods.

The formation of village-groups for protection and the development later of tribal communities resulted necessarily in the radial extension of field "claims"—what our modern politicians, with careless disregard for geometrical terminology, now call "spheres of influence"—always dominated by the extending necessities of agriculture, the growing of crops for food and then, with the scarcity of skins, for textile materials.

The mineralogist and the metallurgist were perhaps before the farmer among those earliest research workers in applied science, but they were small folk, mere specialists in science. They have obtained a place of undue prominence in the minds of our modern students because of the adoption of their products for purposes of terminology in our conventional time-scale for those ages that preceded history. But this is due merely to the durability of implements as index "fossils," and is in no sense a certain indication of their political and industrial importance.

And then afterwards, long afterwards—indeed, up to historically recent times—national boundaries became extended or were fought for, but still mainly because agricultural products in some form were a necessity for the maintenance of communal life. When British traders first went to India, for instance, they extended their influence first along the navigable rivers for the trade in vegetable products which were raised on the alluvial lands around; and so British India, as we call it to-day to distinguish the administered areas from the residual native states, is now mainly agricultural. Even when the permanent settlement of Bengal was made in 1793 no one thought of reserving for the state the underlying coal which has since become so surprisingly important. It was the field, and the field only, that was considered to be of commercial and political importance.

Agricultural products, therefore, until recently dominated the political ambitions of national units. Whether, and to what extent, the possession and use of mineral resources may now modify that dominant

[2] The Witwatersrand.

spirit is the principal question to which I wish to invite your attention this evening.

In the evolution of man, as in the evolution of the animals that occupied the world before him, there are no sharply defined, world-wide period limits: the preagricultural Bushman still survives and lives the life of preagricultural man in this Union of South Africa. The recognition of agriculture as a leading inspiration for acquiring and holding territory has been modified occasionally by "gold rushes" into lands previously unoccupied, but they have generally had a temporary, often a relatively small, importance. The "gold fever" may be what our lighter species of newspaper calls "dramatic," but a fever is a short item in the life of a healthy man; heat-waves do not make climates. Possibly our school children are still told that Australia is noted for its goldfields, but the whole of the gold produced there since its discovery in 1851 is less in value than that of three years' output of Australian agriculture.

Even here in South Africa, which produces half the world's supply of gold, the value of the metal is still less than that of the pastoral and agricultural products. It is true that gold and diamonds introduced temporary diversions in the political expansion of South Africa, but the dominant interests of the Union are still determined by the *boer-plaas* and the *weiveld.*

The adventures of the Spanish *conquistadores* in the sixteenth century and of their enemies, the sea-roving Norse buccaneers, were inspired by stories of gold in El Dorado. And yet the whole of the South American output of gold, even under its modern development, is almost negligible beside the pastoral and agricultural products—wheat, maize, wool, tobacco, coffee, cocoa, sugar, meat and hides. The total production of gold for the whole continent last year was worth no more than a hundredth part of the surplus of agricultural products which the Argentine alone could spare for export. Truly there is a substantial difference between the bait and the fish, between the sprat and the mackerel.

The discovery and colonization of a continent are not the only ways in which the lure of gold has often brought results more valuable than the metal itself. The efforts of philosophers from the time of the Alexandrian Greeks in trying to transmute the base metals into gold resulted in accumulating the raw materials with which Paracelsus laid the foundations of a new chemistry.

Metals, we know, have been used since early times for simple implements and weapons, but it was not until the industrial revolution in Great Britain that the mechanization of industries led to any considerable development of our mineral resources, first slowly and with a limited range of products, then on a large scale and with an extended variety.

But to distinguish clearly cause from effect is not always simple. We were told at school of the remarkable series of inventors who laid the foundation of the textile industries in the north of England, and of the timely invention of the steam engine; its application to mine pumping; the successive construction of the steamer and the locomotive; the production of gas from coal. But the close association of ore, fuel and flux made it possible not only to improve machinery but also to increase facilities for the transport of raw materials and their products. When Josiah Wedgwood obtained his inspiration from the remains of Greek art then being unearthed from the ancient graves of Campania, he first turned to account the raw materials of his native county of Staffordshire, and then promoted canal and road construction to introduce the china clay from Cornwall.

It is obvious that the growth, if not with equal certainty the origin, of the industrial revolution was due to the close association of suitable minerals in England. It was because non-phosphoric ores were still available that, at a later stage, Bessemer was able to give that new impetus which increased the lead of the English steel maker; and so, when Thomas and Gilchrist came still later with their invention of a basic process applicable to pig-iron made from phosphoric ores, their invention fell on barren soil in Britain. The new process, however, found applications elsewhere, and, instead of adding to the stability of the English steel industry, it gave the United States the very tonic they required, whilst the industrialists of Germany—where political stability had by then been established—found the opportunity of developing the enormous phosphoric ore deposits of Alsace-Lorraine, which had been borrowed from France eight years before. And so it was through the genius of Sidney Gilchrist Thomas, and his cousin, Percy Carlyle Gilchrist, that Germany was enabled in 1914 to try the fortune of war.

For the first half century after the industrial revolution, Great Britain was able to raise its own relatively small requirements of iron as well as of the other metals that consequently came into wider use—copper, zinc, lead and tin. The rapid expansion in steel production which followed Bessemer's announcement of his invention at the Cheltenham meeting of the British Association in 1856 brought with it the necessity of going further afield for the accessory ores and for further supplies of non-phosphoric iron ores.

The next important step in metallurgical advance came in 1888, when Sir Robert Hadfield produced his special manganese-steel, for this led to the production of other ferro-alloys and so extended our requirements in commercial quantities of metals which were previously of interest mainly in the laboratory—vanadium, tungsten, molybdenum, aluminium, chro-

mium, cobalt and nickel. The adoption of alloys, especially the ferro-alloys, at the end of the last century opened up a new period in the newly established mineral era of the world's history, for, beside the increase in the quantity of the commoner base metals which were wanted for the growing industries of Great Britain, it was necessary now to look further afield for supplies of those metals that had hitherto been regarded as rare in quantity and nominal in value.

The country in which the industrial revolution originated and gathered momentum, because of the close association of a few base metals, could no longer live on its own raw materials, and never again will do so. Even in peace time Great Britain alone consumes twice as much copper and just as much lead as the whole empire produces. Meanwhile, developments had occurred elsewhere, notably in Germany, where political stability had been secured, and in the United States, where the Thomas-Gilchrist process also had stimulated expansion. Thus, by the beginning of the twentieth century, the industrial activities of the world had entered a new phase, which was characterized, if not yet dominated, by the necessity for minerals to maintain the expanding arts of peace.

From this time on no nation could be self-contained; a new era of international dependence was inaugurated, but the extent and the significance of the change was not consciously realized by our public leaders until 1914, when it was found that the developments of peace had fundamentally changed the requirements for war. Indeed, not even the German General Staff, with all its methodical thoroughness, had formed what the tacticians call a true "appreciation of the situation." Two illustrations of shortsightedness on both sides are sufficient for the present argument. Up to the outbreak of war, although the wolfram deposits of South Burma were worked almost entirely by British companies, the whole of the mineral went to Germany for the manufacture of the metal, tungsten, which was an essential constituent of high-speed tool steel. Sheffield still occupied a leading place in the production of this variety of steel, but was dependent on Germany for the metal, which the Germans obtained mainly from British ore. Under the compulsion of necessity, and without consideration of commercial cost, we succeeded before the middle of 1915 in making tungsten, whilst Germany, failing to obtain an early and favorable decision in war, used up her stocks of imported ore and turned to the Norwegian molybdenum for a substitute, until this move again was partly countered by our purchase of the Norwegian output. Germany then found that she wanted ten times more nickel than Central Europe could produce, so she imported her supplies from the Scandinavian countries, and they, being neutral, obtained nickel from another neutral country, where the Canadian ores—the world's main source—had hitherto chiefly been smelted and refined. We thus not only realized our dependence on other lands for the essential raw minerals, but we also had the mortification of finding that, through our own previous shortcomings in the metallurgical industries, we were compelled to face lethal munitions made of metal obtained from our own ores.

The political boundaries of the nations, originally delimitated on considerations dominantly agricultural in origin, have now no natural relation to the distribution of their minerals, which are nevertheless essential for the maintenance of industries in peace time as well as for the requirements of defense. This circumstance, as I hope to show in the sequel, gives a special meaning to measures recently designed on supplementary lines in Europe and America for the maintenance of international peace, measures which, as I also hope to show, can succeed only if the facts of mineral distribution become recognized as a controlling feature in future international dealings.

If minerals are essential for the maintenance of our new civilization, they are, according to the testimony of archeology and history, worth fighting for; and if, according to the bad habits which we have inherited from our Tertiary ancestors, they are worth fighting for, their effective control under our reformed ideas of civilization should be made an insurance for peace. In so attempting to correlate the facts of mineral distribution with questions of public policy, there is no danger of introducing matters controversial; every one here must agree on two things, namely, our desire and even hope for international peace, and consequently the necessity of surveying the mineral situation as developments in technological science change the configuration of the economic world.

Since the industrial revolution in Great Britain, the increase of mechanization and consequent consumption of metals has been accelerated with each decade. It is not necessary to quote the statistical returns available for estimating the rate of this acceleration, for it can be expressed in a single sentence which justifies the serious consideration of every political economist: during the first quarter of this present century alone, the world has exploited and consumed more of its mineral resources than in all its previous history, back to the time when Eolithic man first shaped a flint to increase his efficiency as a hunter.

To save you from the narcotic effect of statistical statements, I will limit myself to one illustration of this generalized statement, for this special example not only illustrates the rate of general acceleration in exploitation, but introduces an important subsidiary question, namely, the way in which activity is becom-

ing pronounced, if not substantially limited, to a group of special areas. In the year 1870 the United States produced 69,000 tons of steel; in 1880, one and one quarter million tons; in 1890, four and one quarter millions; in 1900, ten millions, and in 1928, forty-five millions.

Figures like these raise questions regarding the future which would take us beyond our present thesis. For the present we can assume with fair confidence that, taking the world as a whole, the depletion of natural stores is not yet alarming, although the rate of acceleration, by reason of its local variation, forces into prominence some international problems which will influence, and if effectively tackled will facilitate, the efforts to stabilize conditions of international relations.

I have elsewhere[3] made estimates of the quantities of metals stored in that part of the outer film of the earth's crust which may be regarded as reasonably accessible to the miner. The actual figures in billions of tons convey no precise mental impression to us and need not be quoted here, but certain of the outstanding conclusions have a bearing on our present line of argument.

The first feature of surprising interest to the man in the street is perhaps the relative abundance of those metals with which he is familiar in the arts—copper, lead, tin, zinc and nickel. Nickel, in spite of its price and limited use, is twice as abundant as copper, five times as abundant as zinc, ten times as abundant as lead and from fifty to one hundred times as abundant as tin. There are, indeed, among the so-called rare metals some which are distinctly more abundant than lead, although this is the cheapest of the lot in price and is consumed at the rate of over a million tons a year.

And so one gets at once an indication of two important features. Firstly, the miner works only those deposits in which the metal is concentrated sufficiently to make their exploitation a profitable business; and secondly, the metalliferous ores vary greatly in the completeness with which they have been concentrated in special places to form workable ore-deposits. Nickel-ore, for instance, occurs under conditions which conspicuously hinder its freedom of local concentration, and consequently the wide distribution of the metal and its relative abundance bring little comfort to those who are anxious about their supplies of a metal which jumps suddenly into importance with every rumor of war. We are safe in predicting that we shall never recover for use in the arts any fraction of our total supplies of nickel as large as we shall of most of the others which have been mentioned. Indeed, nickel stands apart from the others, for, whilst it is important in peace time and is dangerously important during war, yet, under the present state of mining and metallurgical practice, the deposits in the world worth working for nickel can be numbered on the fingers of one hand, and nine tenths of our supplies come from a single district in Canada.

Before discussing more precisely the significance of this and similar facts on the question of international relationships, let us consider for a moment the nature of our exploitation methods. Our reference to nickel shows that the metalliferous ores vary in their degrees of concentration, and, therefore, in their suitability for working, but, as the result of estimates made for a few common metals, we shall not be far from the average in assuming that we shall never recover more than about one millionth of the total that lies within workable distance from the surface of our accessible dry land. And another conclusion, based on a similar group of calculations, shows that our greatest total tonnages are not contained in the rich deposits, but in those of low grade.

It follows, therefore, that every advance in metallurgical science and in mining technology that makes it possible to work our low-grade ores adds appreciably to the actuarial value of civilization, for our mineral resources can be worked once and once only in the history of the world, and when our supplies of metalliferous ores approach exhaustion, civilization such as we have now developed during the last century must come to an end. When a miner raises a supply of ore in concentrated form for the metallurgist, he damages, and so places beyond reach forever, far larger quantities of residual ore than he makes available for use. When a metallurgist takes over the product of the miner and separates the refined metal for use in the arts, he also incurs serious losses, although not to the same extent. There are thus before both the miner and the metallurgist opportunities for extending the actuarial value of civilization; and because the cost of labor is the principal constituent in the total bill, and has recently swamped contemporaneous advances in technology, the gradual elimination of manual labor by mechanization is obviously the most profitable line of research.

But mechanization carries with it in general a tendency to limit operations to the larger deposits, with the concurrent neglect of those propositions which are widely scattered over the earth, and, though individually small, represent in the aggregate a serious section of our limited resources. And so our operations in mining, with the family of industries dependent on minerals, tend more and more to be restricted to a few special regions where work can be done on a large scale.

So now, with this thumb-nail sketch of the way in which the new mineral era is developing, we are free

[3] Presidential address, Institution of Mining and Metallurgy, *Trans.*, Vol. xxxiv, 1925, p. lvii.

to examine more closely the influence which this change in the configuration of the industrial world is likely to have on international relationships.

In the first place, it becomes obvious that no single country, not even the United States, is self-contained, whether for the requirements of peace or for the necessities of war. Not even the more scattered sections of the earth that are politically united to form the British Empire contain the full variety of those minerals that are the essential raw materials of our established activities.[4] Between them these two—the British Empire and the United States—produce over two thirds of the two thousand million tons of mineral that the world now consumes annually. Each of them has more than it wants of some minerals, but, in order to obtain its own requirements at economic rates, each finds it necessary to sell its surplus output to other nations. Each produces less than it wants of some minerals, and so must obtain supplies from other nations to keep its industries alive. Each of them is practically devoid of a few but not always the same minerals, which, though relatively small in quantity, are none the less essential links in the chain of industrial operations. Even if these two could "pool" their resources they would still be compelled to obtain from other nations the residual few. For it is important to remember that, unlike organic substance, it is not possible to make synthetic metals, and it never will be; it is not even possible to make artificial substitutes for many essential minerals that are used as such and not merely for their metallic constituents. There is no other mineral and no artificial substance, for instance, that can combine the qualities which give to the mineral mica its position of importance in the arts—its fissility in thin sheets, its transparency to light and opacity to heat rays, its stability at high temperatures, its toughness and the degree of its insulating properties. There will never be a synthetic mica.

Thus the international exchange of minerals is an inevitable consequence of our new civilization, and the cry for freedom of movement, for the "open door" and for equal opportunity for development comes into conflict with the unqualified formula of "self-determination." Whatever may have been possible before the industrial revolution, when the mineral industry merely contributed to the simple wants of agriculture, when most national units were self-contained, the formula of "self-determination" has come too late in the world's history to do good without a more than consequent amount of harm. We can not even live now without the free interchange of our minerals for those of other nations; in the name of civilization we dare not go to war.

There is one more group of fundamental data to recall before we are in a position to point the practical lessons which follow from the newly established and prospective mineral situation. I have already referred to the way in which economic considerations tend, through large-scale production, to restrict operations to a limited number of specially favored areas. There was a time within my memory when the primitive *lohar,* a survival of the aboriginal inhabitants of India, could be found in every province, nearly every district. He collected the granular mineral from the weathered outcrops of relatively lean iron-ore bodies, and, by using charcoal as a fuel, turned out blooms of malleable iron in a miniature clay furnace, using a pair of goat skins to produce the necessary blast. These primitive workers also produced small ingots of steel by the carbonization of wrought iron in clay crucibles many centuries before the same process made Sheffield famous.

But with the large-scale production of steel in western countries, attended by the opening of the Suez Canal, cheaper transport by steamers and the spread of railways from the coast of India, the *lohar* has been exterminated from all but the most remote parts of the country. His history is similar to that of other workers; the small ore-bodies that he used are of no interest to the modern ironmaster, and one result therefore of the modern movement is the neglect of a large fraction of our total resources. We are discussing, however, what is actually happening, not what we think should be a less wasteful course of evolution; natural evolution, like "trial and error" methods, is always wasteful.

Primitive workers in various lands have opened up to relatively shallow depths rich but small deposits of other ores, and in Eastern countries especially, where forms of civilization extend far back into history, the numerous and wide-spread "old workings" have given rise to travelers' impressions of great mineral wealth. But low-grade deposits that the ancient miner could not utilize are now opened up by mechanical methods on a large scale, and, on the other hand, what satisfied

[4] For purposes of reference I give a list of minerals showing how the resources of the British Empire, so far as our present information goes, can be relied on. This list has been kindly revised by Mr. T. Crook, of the Imperial Institute. (1) Those for which the world now depends mainly on the empire: asbestos, china clay, chromite, diamonds, gold, mica, monazite, nickel and strontium. (2) Those of which we have enough and to spare: arsenic, cadmium, cobalt, coal fluorspar, fuller's earth, graphite, gypsum, lead, manganese, salt, silver, tin and zinc. (3) Those in which we could be self-contained if necessary: bauxite, barium minerals, feldspar, iron ore, magnesite, molybdenum, platinum, talc, tungsten and vanadium. (4) Those for which we are now dependent on outside sources: antimony, bismuth, borates, copper, petroleum, phosphates, potash, pyrites, quicksilver, sulphur and radium. A corresponding list for the United States was prepared in 1925 by a committee under the chairmanship of Professor C. K. Leith, and published under the joint authority of the two mining and metallurgical institutions in New York.

the primitive metallurgist in abundance would be of little use to the modern furnace.

We have now to revalue the tales of travelers which have had a dangerous influence on those who have directed the course of international competition; we have to strike out of consideration the integers of the primitive worker to whom a great tonnage would form a mere decimal point in the modern unit; we have to realize that our mid-Victorian standards of metal production are gone forever, and that the comforting after-war formula of "back to normal" is merely a hypnotic drug to conceal the uncomfortable, one might say regrettable, dynamic conditions which have since developed at a speed that is not sufficiently recognized within our empire.

It is now misleading to speak of the wide distribution of minerals within a country as we could have done some fifteen years ago; we must now rule out the smaller deposits, and so form a new picture composed of those concentrations that are on a scale sufficient to support modern metallurgical units.

For this reason it is necessary to review afresh the resources of the undeveloped Far East, which has for many years been regarded as a menace to Western industrial dominance. The vague general notion that mineral deposits are evenly distributed throughout the earth's crust has fed the impression that the development of China, which is much larger than the United States, may yet shift the center of industrial gravity when her great population becomes awakened and organized by Western technical science.

It is true that the people of the East are rapidly adopting the methods and using the mechanical facilities of Western nations—railways, telegraphs, power factories, steel ships and other metal-consuming devices; but the critical investigations made by mining geologists, especially since the war, tend, with a striking degree of unanimity, towards recognizing the remarkable circumstance that China, as well as other countries of the Far East, is deficient in those essential deposits of minerals on which our mechanized form of civilization is based.[5]

When China was still an unknown land it was possible for after-dinner speakers to impress non-critical hearers by talk of the "yellow peril" and the "challenge of Asia," but these expressions have been used without thought of the circumstances that natural resources in minerals now set a rigid limit to power, whether industrial or military. We have known for some time of the natural limitations of India, of Japan and of smaller political units in the East, but until very recently we have had insufficiently precise data for estimating the quantitative value of the terms "vast" and "unlimited" which have been so often applied to China. Assuming that China may yet become a homogeneous national unit, or even assuming that her resources may become developed by Japanese energy, there is very little doubt now that, as an industrial area, the country is deficient in those minerals that form the essential basework of the modern form that civilization has definitely taken.

And the obvious limit in development, as defined by local natural resources, can be extended only to a limited degree by the importation of raw materials from other areas, for a country can buy metals only by the exchange of other products; its buying powers are limited by its selling powers. Abundant cheap labor, assisted by a semi-tropical climate, can produce an exportable surplus of foodstuffs only in limited parts of the Far East; even the so-called luxury products, which to our early navigators formed the inspiration of what we call geographical research, are now obtained elsewhere, and some are being replaced by artificial products evolved from the chemical laboratory.

Exploratory work by mining geologists tends more and more to show that the essential mineral products are far from evenly distributed over the land areas of the world. Western Europe and North America have an undue share of those deposits that can be worked on a large scale, and it is the large-scale movement that marks the specialized character of the new industrialism. Anglo-Saxon character would have found limited scope for its energy but for the fact that nine tenths of the coal, two thirds of the copper and as much as 98 per cent. of the iron-ore consumed by the world come from the countries that border the North Atlantic. Dr. Wegener might like to add this fact to the data on which he has based his theory of drifting continental fragments.

The industrial revolution, which began in Great Britain, has always been recognized as a dominant phase in Western civilization, but it is now assuming a new character. It spread first to the western countries of Europe, and developed there because of the favorable conditions of mineral resources, but the force of the movement faded out towards the Slavic East and the Latin South; the mechanical industries of Italy are based on imported scrap. When the new industries became transplanted west of the Atlantic the natural conditions which originally favored Great Britain were found to be reproduced on a larger scale.

Thus, in these two main areas, separated by the Atlantic Ocean, a family of industries based on mineral resources has arisen to dominate the world, for no similar area, so far as our geological information tends to show, seems to combine the essential features in any other part of the world. Other parts of the world will continue to supply minor accessories, and

[5] A comprehensive study of this question with bibliography has recently been published by a competent and judicial authority, H. Foster Bain, "Ores and Industry in the Far East," 1927.

the isolated basic industries associated with coal and iron will supply local needs on a relatively small scale. But political control, which follows industrial dominance, must lie with the countries that border the North Atlantic.

It is only in this region that there is any approach to the state of being self-contained. And yet since the war there has arisen, first in Europe and then by imitation in Asia, a degree of national exclusiveness more pronounced than any which marked international relations before 1914. Each small political unit has become vaguely conscious of the value of minerals, and has shown a tendency to conserve its resources for national exploitation on the assumption that they add appreciably to military security.

There is, however, no such thing now as equality of nations in mineral resources; "self-determination" and the "closed door" are misleading guides to the smaller nations. Political control may hamper, but can not stem, the current of the new industrialization; commercial and industrial integrations are stretching across political boundary-lines, and the demand for the interchange of mineral products will be satisfied in spite of fiscal barriers.

It would have been a shock to our members if, before the war, political problems were discussed from this chair, and party politics may always be inconsistent with the mental products of culture. But the results of science and technology now limit the effects of national ambitions, and therefore dominate the international political atmosphere for good or evil. One is justified always in suggesting non-controversial measures that tend to good, and this it is proposed to do very briefly as the direct suggestion of the new configuration of the mining and metallurgical world.

The League of Nations has accomplished a large measure of international understanding in questions of social value; its influence in forestalling possible causes of war has raised new hopes; but fortunately, so far, it has not been compelled to use any such instrument of force as a blockade, and any such measure that clashed with the vital economic considerations of first-class powers would probably cause stresses well beyond its elastic limits. The more recent and simpler pact of Paris associated with the name of Mr. F. B. Kellogg wants equally an ultimate instrument for its practical enforcement.

It was with this ultimate object in mind that the outline of my argument was drafted after the Glasgow meeting last year; but I am glad to find that my views have since been expressed independently. Senator Capper, of Kansas, in February last submitted a resolution to the American legislature recognizing this shortcoming of the simple treaty, and proposing to supplement its moral obligations by a corollary which, if passed, will empower the government on behalf of the United States to refuse munitions to any nation that breaks the multilateral treaty for the renunciation of war.

Senator Capper's resolution, however, still leaves unsolved a residual problem of practical importance. Those of us who had the painful duty of deciding between civil and military necessities in the great war know well that there is now but little real difference between the materials required to maintain an army on a war footing and those that are essential to the necessary activities of the civilian population; *materials* essential for one purpose can be converted to *articles* required for the other. Thus, if Senator Capper's resolution be adopted by those who have signed the Kellogg Treaty, either sympathy for the civil population would be stirred, or the armies would be still supplied with many essential munitions: the definition of "conditional contraband" would still remain as a cause for international friction.

A formula, still simpler but equally effective, is indicated by this review of the new situation arising from the essential use of minerals. It is suggested, therefore, as an amendment to Senator Capper's resolution, that the simple words "mineral products" be substituted for "arms, munitions, implements of war or other articles for use in war."

The only two nations that can fight for long on their own natural resources are the British Empire and the United States. If they agree in refusing to export mineral products to those countries that infringe the Kellogg Pact, no war can last very long. As our friends across the Atlantic have recently learned, it is easier to stop exports than to prevent imports: the customs' officer is more effective, less expensive and far less dangerous than a blockading fleet.

The confederation of American states has the advantage of forming a compact geographical unit, without interstate fiscal barriers to hamper the interchange of mineral products. The British Empire, in the words of President Nicholas Murray Butler, "has passed by natural and splendid evolution into the British Commonwealth of Nations"; it is composed of geographically scattered and independent political units, among which freedom of interchange, with due regard to local interests, can be effected safely only by more complete knowledge of our resources. Next year the Empire Congress of Mining and Metallurgy will meet in this city to discuss the proposition which I submitted to it at Montreal in 1927; and this address must be regarded, therefore, as an introduction to a movement which one hopes will supply the necessary data, and so facilitate a working agreement between the two great mineral powers that alone have the avowed desire and the ability to ensure the peace of the world.

SCIENTIFIC EVENTS

THE PAN-AMERICAN INSTITUTE OF GEOGRAPHY AND HISTORY

An assembly, at which will be formally organized the Pan-American Institute of Geography and History, will be held in the City of Mexico from September 16 to 22. A rather extensive plan is outlined for the meeting, the first session of which will be held in the Pan-American Hall of the Treasury Department. The address of welcome will be delivered by the chief of the federal district and later in the day the delegates will be presented to the president of the republic.

September 17, 18 and 19 will be devoted to discussion of the statutes for the formation of the institute. A plan for the creation of such an institute was officially presented by the Mexican government through its delegation to the Sixth Pan-American Congress held in Havana in January, 1928. The presiding officer at the sessions on these three days will be Dr. Pedro C. Sánchez, director of Geographical and Climatological Research in Mexico, who first proposed the creation of such an institute and who was technical adviser to the Mexican delegation at the meeting in Havana. On the twentieth will occur the nomination and election of the executive committee of the institute and the selection of the place where the first congress will be held. Following the completion of this business, the delegates will be taken to the Department of Geographical and Climatological Research, located in Tacubaya, a suburb of Mexico City. While there an opportunity will be afforded them to visit the building which the Mexican government is now erecting for the offices of the Pan-American Institute of Geography and History. The assembly will be formally declared closed at a reception given that night by President Portes Gil at Chapultepec Castle.

Several interesting excursions are planned for the delegates by their Mexican hosts, including sightseeing trips about the capital and its environs, and a trip by special train to the School of Agriculture in Chapingo, where a banquet will be given by the Secretary of Agriculture. The delegates will also be taken by special train to the archeological ruins at San Juan Teotihuacán where a banquet will be given by the Secretary of Public Education. Another excursion will be made to the Caverns of Cacahuamilpa, under the auspices of the Secretaries of Communication and Public Works and of Industry, Commerce and Labor. The chief of the Federal District will entertain the delegates at a reception in the Municipal Palace.

THE BASHFORD DEAN MEMORIAL EXHIBIT OF FOSSIL FISHES

The exhibit of fossil fishes in the southeast pavilion of the fourth floor of the American Museum of Natural History, a memorial to the late Bashford Dean, first curator of fishes in this museum, was opened on the afternoon of June 10. President Henry Fairfield Osborn presided over the short meeting which was attended by the immediate family and many personal friends of Dr. Dean, including a number of his colleagues from the two universities (Columbia and New York) in which he was a professor, and the two museums (the American Museum of Natural History and the Metropolitan Museum of Art), in both of which he was long a curator.

President Osborn read a cablegram from Dr. W. K. Gregory, curator of fishes, who is at present on an expedition to Africa. He then paid a brief tribute to Dr. Dean as his student, colleague and friend, and asked Miss Francesca La Monte, assistant curator, to unveil the bronze *bas-relief* tablet which is the gift of his friends from all over the world. He then asked Mr. J. T. Nichols, curator of Recent fishes, to say a few words in explanation of the exhibit. Next he called on Dr. E. W. Gudger, bibliographer and associate in the department, who gave a brief history of the great Dean "Bibliography of Fishes" and of its continuation, and of the plan for the publication of a memorial atlas of the valuable unpublished plates, drawn by Dr. Dean himself, portraying the outer development of certain primitive sharks.

Among the noteworthy collections represented in this exhibit are that of Devonian placoderms made by Professor J. S. Newberry (Dr. Dean's teacher in paleichthyology), the E. D. Cope collection and the Alfred Ely Day collection from Mt. Lebanon, Syria. These form the basis of the exhibit, which from time to time has been augmented by other specimens.

FIELD PARTIES OF THE OKLAHOMA GEOLOGICAL SURVEY

Chas. N. Gould, director of the Oklahoma Geological Survey, announces the organization of the following twelve field parties for the present field season:

Charles E. Decker, professor of paleontology at the University of Oklahoma, with assistants Norval Ballard and Ross Maxwell, is making a detailed study of the Simpson formation and the Viola limestone in the Arbuckle Mountain region, this being the third summer Dr. Decker has pursued work in this general region.

Samuel Weidman, professor of geology at the University of Oklahoma, is continuing his studies in the

lead and zinc areas of northeastern Oklahoma. W. A. Wilson, of Princeton University, with Thomas L. Metcalf, as assistant, will start about August 10 to study coal outcrops in Muskogee County, Oklahoma, this being a continuation of the work carried on during the last two years by Dr. W. T. Thom, of Princeton. C. A. Merritt, assistant professor of geology at the University of Oklahoma, assisted by W. M. Plaster, is conducting studies in the Hennessey shale of north-central Oklahoma.

John S. Redfield, assistant geologist of the Oklahoma Geological Survey, is undertaking the collection of a large number of samples of Oklahoma clays, the same to be tested by the department of ceramics at the Oklahoma A. and M. College at Stillwater. J. R. McGehee, who has recently been named paleontologist of the Oklahoma Geological Survey, is undertaking the collection and description of the Pennsylvanian fossils of the state.

Professors F. A. Melton, R. L. Six and H. A. Ireland, of the department of geology, and W. F. Cloud, of the school of petroleum engineering of the University of Oklahoma, are undertaking the preparation of reports on the oil and gas geology of various counties of the state, this to complete Bulletin 40 of the Oklahoma Geological Survey which is being published as separate chapters. John A. McCutchin, American Petroleum Institute research observer on geothermal gradients for Oklahoma, will continue his work on deep-well temperatures on various oil fields in the state. C. L. Cooper, chief geologist of the survey, assisted by J. R. McGehee, paleontologist, expects to make an extended trip during October and November studying Mississippian formations in Oklahoma, Arkansas, Missouri, Iowa, Illinois, Indiana, Ohio, Kentucky and Tennessee.

CONFERENCE OF THE GENERAL ELECTRIC COMPANY

TWENTY-FOUR professors of engineering in as many colleges and universities attended the five-weeks' professors' conference conducted this year, as in previous years, by the General Electric Company.

The conference opened on July 1 and continues through August 3. During that period the visitors will have had the opportunity to study developments in electrical and mechanical engineering in an industrial plant. On July 10 and 11, the visitors had an outing at French Point on Lake George. On July 11, they journeyed to Pittsfield, Massachusetts, by bus, to inspect transformer work at the General Electric plant there. July 12 and 13 were passed at the River Works and West Lynn works of the company at Lynn, Mass. Those in attendance are: Dean Paul Cloke, University of Maine; N. B. Ames, George Washington University; S. W. Anderson, Virginia Military Institute; F. E. Canavaciol, Brooklyn Polytechnic Institute; R. F. Chamberlain, Cornell; E. P. Culver, Princeton; P. A. Cushman, Vanderbilt; O. E. Edison, University of Nebraska; W. N. Espy, University of Illinois; S. T. Fife, University of Louisville; L. S. Foltz, Michigan State College; L. J. Hodgins, University of Maryland; P. L. Hoover, Case; F. D. Jackson, University of New Hampshire; R. P. Kolb, North Carolina State College; W. F. Mallory, University of Colorado; R. M. Matson, Georgia Tech; F. H. Pumphrey, Rutgers; D. P. Randall, Syracuse; H. E. Richards, Northeastern; C. W. Ricker, Tulane; W. T. Ryan, University of Minnesota; J. T. Strate, University of Arkansas; A. P. Strom, University of Iowa.

The following professors and instructors are employed at the Schenectady plant for the summer: R. C. Putnam, Case; C. C. Whipple, Brooklyn Polytechnic; H. A. Everett, Pennsylvania State; J. A. King, University of Kansas; R. E. Clark, Cornell; C. M. McCormick, Colorado; S. S. Attwood, University of Michigan; A. A. Nims, Newark Tech; J. M. C. Porter, Carnegie; C. W. Hoilman, Virginia Polytechnic Institute; L. Conover, Lafayette; E. G. Keller, University of Texas; E. C. Litman, A. D. Hummell, C. M. Green, A. A. Bennett, C. A. Keener, G. A. Goodenough, of University of Illinois; C. E. Magnusson, University of Washington; J. M. Bryant, University of Minnesota; Comfort A. Adams, Harvard; R. W. Sorensen, California; C. V. Mueller, Kansas State College.

The following professors and instructors are employed in the research laboratory: J. M. Beams, University of Virginia; P. H. Carr, Cornell; H. E. Edgerton and C. F. Munkenhaupt, Massachusetts Institute of Technology; J. H. Johnstone, Tallahassee; T. M. Kruger, Cornell; E. Lawrence, University of Virginia; P. Lowe, Queens; D. Ramadanoff, Cornell; Guy Suits, Wisconsin; F. W. Warburton, University of Oklahoma; J. W. Williams, Wisconsin; C. H. Willis, Princeton; W. T. Kearton, University of Liverpool.

THE WOODS HOLE STATION OF THE BUREAU OF FISHERIES

THE U. S. Fisheries Biological Station at Woods Hole opened on June 17 for the 1929 summer season under the direction of Oscar E. Sette. Three of the bureau's major investigations have headquarters at Woods Hole this season. Dr. Paul S. Galtsoff, with three assistants, is continuing his investigations on the physiology of oysters and the ecology of oyster beds in the vicinity of Woods Hole, Massachusetts. The studies on the shore fisheries of the Middle Atlantic coast continue under the direction of Robert A. Nes-

bit, who will have his headquarters at Woods Hole. The activities at this station will include studies of the occurrence and growth of young squeteague, scup and other shore species of the Woods Hole region. Experiments in methods of tagging and marking these fishes will also be conducted during the summer. The activities of field observers who are collecting data on the catch of pound nets in various localities in the states of New York, New Jersey and Virginia will be directed from this station.

The mackerel investigations are being continued at Woods Hole, where Oscar E. Sette, assisted by Edward W. Bailey, is working on the growth of juvenile mackerel and the analysis of extensive plankton collections made by the *Albatross II* during the 1929 spawning season for their content of mackerel eggs and larvae. Dr. Roderick MacDonald and George L. Clarke will collaborate in analyzing the offshore plankton collected incidentally to the mackerel investigations, with special reference to the relative abundance of the various organisms and their effect on the movements of adult mackerel and their survival.

Studies on the physiology of fishes, particularly their respiration and carbohydrate metabolism, are being continued by Dr. F. G. Hall, professor in Duke University, in collaboration with Dr. I. E. Gray, assistant professor in Tulane University. Raymond Root, fellow in zoology at Duke University, has been employed as stockroom keeper and will also collaborate with Dr. Hall, particularly on the biochemical analysis of fish eggs and larvae.

In addition to the bureau's staff of permanent and temporary investigators a number of independent investigators are engaged on various problems of significance to our understanding of the fisheries. Dr. Edwin Linton, University of Pennsylvania, is continuing studies on the helminth parasites of fishes; Dr. C. J. Connolly, associate professor in the Catholic University, will study the color reactions of crabs; Albert J. Dalton, tutor, College of the City of New York, is studying the critical stages in the embryonic development of fishes in the Woods Hole region, and Paul S. Conger, diatomist of the U. S. National Museum, will continue his studies of the marine diatoms in this region.

Four of the university tables are occupied. R. E. Bowen and Kendall W. Foster occupy Harvard tables, Dr. John C. Hemmenter the Johns Hopkins table and M. E. Holcomb the Princeton table. Space has also been accorded Dr. N. A. Cobb, of the Department of Agriculture, and his staff of six assistants, who are conducting research in nematology.

SCIENTIFIC NOTES AND NEWS

At the meeting of the Royal Society of Canada at Ottawa, Professor A. S. Eve, McDonald professor of physics in McGill University, was elected president for the meeting to be held next year at Montreal.

The gold medal of the University of Hamburg was presented on May 6 to Dr. Francis G. Benedict, director, nutrition laboratory of the Carnegie Institution, Boston, following his lecture before the medical faculty.

The Academy of Sciences of Vienna has awarded the Ignaz L. Lieben prize to Dr. Karl Przibram, professor of physics in the university.

The Leslie Dana gold medal for 1929, awarded by the National Society for the Prevention of Blindness in recognition of "the most outstanding achievement in the prevention of blindness and the conservation of vision," will be presented to Dr. Ernest Fuchs, of Vienna, at the International Ophthalmological Congress in Amsterdam on September 10.

It is announced in *Nature* that the Kelvin Medal Award Committee, consisting of the presidents of the leading British engineering institutions, has awarded the Kelvin medal for 1929 to M. André Blondel, engineer of the Ponts et Chaussées since 1889 and for many years the chief engineer of the French lighthouse services, distinguished for his work on signaling apparatus and for his investigations on electrical measurements, apparatus and photometry. The medal is awarded as a mark of distinction in engineering work and investigation of the kinds with which Lord Kelvin was especially identified. Former recipients of the medal are Dr. W. C. Unwin, Professor Elihu Thomson and the Honorable Sir Charles Parsons.

Nature reports that an honorary fellowship of the British Academy has been conferred on Professor A. H. Sayce, known for his explorations and for his work on the archeology of the Near East. He has also been awarded the Huxley Memorial Medal of the Royal Anthropological Institute for 1929, and has been invited to deliver the Institute's Huxley Memorial Lecture in 1930. Professor Sayce is now in his eighty-fourth year, and has been a fellow of Queen's College, Oxford, since 1869.

The Dr. Jessie Macgregor Prize in Medical Science for the triennial period 1929–31 has been awarded to Miss Helen M. Russell, M.D., for her record of work on malaria in the Vasiliki Valley, Macedonia, during 1925. The prize was founded in 1908 as a memorial to the late Dr. Jessie Maclaren Macgregor, of Edinburgh, and is of the value of £75.

Dr. H. S. H. Wardlaw, of the department of physiology of the University of Sydney, has been elected president of the Linnean Society of New South Wales for the current session.

H. H. Magdsick, who is director of commercial engineering at the National Lamp Works, Cleveland, has been elected national president of the Illuminating Engineering Society for the year 1929–30. He takes office on October 1.

At the quarterly meeting of the council of the Royal College of Surgeons, London, Lord Moynihan was reelected president, and Mr. C. H. Fagge and Mr. V. Warren Low were elected vice-presidents for the ensuing year. Mr. R. H. Burne (physiological curator), Mr. C. F. Beadles (pathological curator), Sir Frank Colyer (honorary curator of the odontological collection) and Mr. C. J. S. Thompson (honorary curator of the historical section of the museum) were reelected to their respective posts. Mr. W. R. Le Fanu, second librarian to the Hellenic Society, was appointed assistant librarian to the college. Mr. H. J. Burrows, F.R.C.S., was appointed Beaverbrook research scholar. He will pursue tissue culture research at the research hospital, Cambridge. The Hallett prize for anatomy and physiology was awarded to L. A. Riddell, New Zealand.

Dr. Alexander Pogo, of the Yerkes Observatory, has been appointed fellow in the history of science by the Carnegie Institution of Washington. He will work in the library of Harvard University.

Fred L. Garlock, who for the last five years has been a member of the faculty of Iowa State College and also of the Iowa Agricultural Experiment Station where he has carried out research in farm finance and country banking, has been appointed senior research specialist in short-term finance and intermediate credit in the bureau of agricultural economics, of the U. S. Department of Agriculture.

Professor and Mrs. E. B. Van Vleck, of the University of Wisconsin, will sail from San Francisco on August 15, for a trip around the world. Professor Van Vleck retired from active teaching in June, 1929.

W. K. Williams, Jr., of Arkansas, has been appointed extension forester to represent the Forest Service and the office of Cooperative Extension Work in the work which the department and the states carry on cooperatively. He succeeds G. H. Collingwood, who resigned some months ago.

E. Esclangon, director of the Strasbourg Observatory, has been made director of the Paris Observatory. M. Cotton, professor at the Sorbonne, and M. Maurain, dean of the faculty of sciences, have been elected members of the council of the observatory in place of the late M. Daniel Berthelot and of M. Appell, who recently resigned.

Louis O. Sordahl, who has been appointed to take charge of the Smithsonian Institution Solar Station at Mount Brukkaros, Southwest Africa, a British province, sailed from New York on July 27. Mr. Sordahl will make daily observations of the sun's radiations at Mount Brukkaros, which will be compared with the results found by the solar stations at Swartout, California, and in Chile, the results of which will be used to make long-distance weather forecasts.

At the request of Commander MacMillan, Dr. W. C. Kendall, ichthyologist of the Bureau of Fisheries, is accompanying the MacMillan expedition to Labrador and Baffin Land in order to make extensive collections of the fish life of that region.

The personnel of the scientific staff of the Mawson Antarctic Expedition has been announced as follows: Commander, Sir Douglas Mawson; medical officer, Dr. Wilson Ingram, Sydney; senior zoologist, Professor Harvey Johnston, Adelaide; taxidermist, Mr. H. O. Fletcher, Sydney; ornithologist, Mr. Falla, New Zealand; chemist, Mr. Alfred Howard, Melbourne; plankton expert, Mr. Marr, of the previous *Discovery* expedition; meteorologist, Mr. H. G. Simmers, New Zealand. A second pilot and another physicist are to be added.

Professor B. H. Crocheron, of the agricultural extension division of the University of California, with W. J. Norton, will sail from San Francisco on August 2 for the Orient, where they will investigate the possibility of markets for California fruit. Professor Crocheron goes as special trade commissioner for the U. S. Department of Commerce, which is cooperating with the university in this investigation.

Dr. G. A. Muilenburg, associate professor of geology at the Missouri School of Mines, is spending a part of the summer examining mineral deposits in West Texas, New Mexico, Utah and Wyoming.

Professor Prossalow, of the Leningrad Academy of Sciences, is expected in Palestine to study local conditions on behalf of the International Congress of Soil Experts, which met in Dantzig. Together with Professor Greifenberg, also of Russia, he will prepare a map of the different grades of soil.

Dr. Erwin E. Nelson, associate professor of pharmacology in the University of Michigan, has been given sabbatical leave for the first semester of the academic year 1929–30, and is to study with Dr. Walther Straub in Munich.

THE U. S. Civil Service Commission states that the position of assistant technical director (chief chemist), Chemical Warfare Service, Edgewood Arsenal, Maryland, is vacant, and that, in view of the importance of this position in the field of chemical research, the qualifications of candidates will be passed upon by a special board of examiners composed of H. E. Howe, editor, *Industrial and Engineering Chemistry;* H. L. Gilchrist, chief of Chemical Warfare Service, and A. S. Ernest, examiner of the U. S. Civil Service Commission. The salary range for the position is from $8,000 to $9,000 a year. Formal applications will be received by the Civil Service Commission until August 28. The position of senior pharmacologist, salary $4,600, will be filled from applications received not later than August 5.

THE Fifth Pacific Science Congress will be held in Canada in 1932. A committee of the National Research Council has been formed to make the preparations.

A SYMPOSIUM on theoretical physics is being conducted at the University of Michigan from June 24 to August 16. The following courses of lectures were announced: E. A. Milne, of the University of Oxford, "Problems in astrophysics, and vector and tensor methods in statics and dynamics"; K. P. Herzfeld, of the Johns Hopkins University, "Statistical mechanics"; Leon Brillouin, of the University of Paris, "Quantum statistics"; Edward Condon, of Princeton University, "Introduction to quantum mechanics"; P. A. M. Dirac, of the University of Cambridge, "Advanced quantum mechanics"; D. M. Dennison, of the University of Michigan, "Band spectra."

THE formal organization of the Comité International d'Histoire des Sciences was effected in Paris last May. The by-laws provide for a maximum of 30 regular members and 50 corresponding members. The officers elected were as follows: Charles Singer, of London, *president;* Florian Cajori, of the University of California; Abel Rey, of Paris, and Karl Sudhoff, of Leipzig, *vice-presidents;* Aldo Mieli, of Paris, *secretary.* The first International Congress on the History of Science was held at Oslo in 1928. The second will be in London in 1931.

THE *Journal* of the American Mathematical Association reports that a Congress of Mathematicians of Slavic Countries will be held at Warsaw, Poland, from September 23 to 27. The congress will have sections in the following subjects: (1) Foundations of mathematics, history, didactics; (2) arithmetic, algebra, analysis; (3) point-set theory, topology and applications; (4) geometry; (5) rational mechanics, applied mathematics. Those who desire to take part in the congress are asked to indicate this to the secretary of the congress where a proper registration blank can be obtained. The congress will be held under the presidency of Professor W. Sierpinski. The address of the secretary is Politechnika, Gabinet Matematyczny, p. 72, Warszawa (Pologne), ul. Polna 3.

Industrial and Engineering Chemistry reports that the American Electrochemical Society will hold its fall meeting in Pittsburgh, Pennsylvania, from September 19 to 21, to discuss, among other subjects, the contributions of the American electrochemical industry to aeronautics. Several hundred chemists, metallurgists, plant executives and company officials of both the United States and Canada will then convene to discuss recent developments in the electrochemical industry. The program will consist of visits to various industrial plants in the Pittsburgh district, and also technical sessions at which papers on electrochemical subjects will be presented by various prominent men from all over the country. There will be a special symposium on "Contributions of Electrochemistry to Aeronautics," with emphasis given to the light-weight aluminum and magnesium alloys used in airplane construction. Social features of the meeting will include a smoker, a dinner and dance and a special program for the ladies. Headquarters will be the William Penn Hotel. Reservations may be made through Mark W. Egan, William Penn Hotel.

THE following appointments have been made at Mellon Institute of Industrial Research, Pittsburgh, Pa., during the current calendar year: *Senior Industrial Fellows:* G. J. Cox, Ph.D. (Illinois, '25), utensil; H. B. Meller, E.M. (Pittsburgh, '10), smoke and dust abatement. *Industrial Fellows:* J. D. Alley, B.A. (Columbia, '17), steel treatment; R. F. Beard, Ph.D. (Minnesota, '28), carbonated beverage; H. G. Botset, B.S. (Purdue, '22), petroleum production; Mary L. Dodds, M.S. (Pittsburgh, '27), utensil; A. W. Johnson, B.S. (Pittsburgh, '25), rosin oil; T. R. LeCompte, Ph.D. (Columbia, '27), hemp paper; A. G. Loomis, Ph.D. (California, '19), petroleum production; R. R. McClure, M.S. (Chicago, '17), pigment; S. U. McGary, B.S. (Texas, '21), petroleum production; E. W. Morrison, Ph.D. (Yale, '29), food container; Beauregard Perkins, Jr., B.A., B.S. (Tulane, '16), petroleum production; P. F. Siegrist, B.Cer.E. (Ohio State, '27), Portland cement; J. T. Stearn, D.Sc. (Polytechnic Institute, Zurich, '23), scale; L. W. Vollmer, B.S. (Pennsylvania State, '26), petroleum production; V. S. Wrenn, Ph.B. (Yale, '18), dental; J. L. Young, Ph.D. (Pittsburgh, '26), heating. *Fellowship Assistants:* J. R. Adams, M.S. (Carnegie Institute, '29), petroleum refining; C. N. Bowers, B.S. (Pittsburgh, '29), petroleum production; S. M. Cooper, B.S. (Pittsburgh, '29), petroleum refining; F. E. Gallagher, petroleum production; Dorothy Hamilton, B.Sc. (Trinity College, Washington,

D. C., '27), smoke abatement; S. R. Hathaway, A.M. (Ohio State, '28), sleep; Eleanor M. Jones, A.B. (Goucher, '29), smoke abatement; J. A. Satosky, B.S. (Pennsylvania State, '29), carbon black; W. F. Speer, B.S. (Pittsburgh, '28), edible gelatin; Mary E. Warga, M.S. (Pittsburgh, '28), smoke abatement; Helen B. Wigman, B.S. (Pittsburgh, '28), utensil; C. G. zur Horst, Met.E. (Pittsburgh, '24), petroleum production.

H. R. TOLLEY, assistant chief of bureau, and Chris L. Christensen, in charge of the division of cooperative marketing, Bureau of Agricultural Economics, have been invited to attend the International Conference of Agricultural Economics in England, which meets from August 26 to September 7. Other American economists who have been extended an invitation to the conference are: Dr. C. E. Ladd, Dr. G. F. Warren, Dr. F. A. Pearson, and Dr. Leland Spencer, all of the New York State College of Agriculture; Dr. H. C. Taylor, director of the comprehensive survey of rural Vermont for the Vermont Commission on Country Life; F. P. Weaver, of Pennsylvania State College; H. A. Wallace, of *Wallace's Farmer,* Des Moines, Iowa; Dr. G. A. Pond, of the Minnesota State College of Agriculture, and H. C. M. Case, of the Illinois State College of Agriculture. The delegation expects to sail on the steamship *Leviathan* from New York on August 17. The conference, which will bring together men engaged in economic research in the United States, Canada, England and some northern European countries, was planned by Dr. Ladd, Professor C. W. Orwin, of the research institute of agricultural economics at the University of Oxford, and Leonard K. Elmhirst, of Dartington Hall, Devon, England. It is the desire of the group to further the field of agricultural research by bringing together the men who are actively engaged in this work in the various countries, for the interchange of information as to methods and procedure, in order that each may be helped by the experience and research of the others.

SUBSTANTIAL progress is reported towards the arrangements for the World Poultry Congress of 1930, which is being organized by the British Ministry of Agriculture. Provision is being made for displaying large flocks of poultry in the grounds of the Crystal Palace, and the conditions under which these are to be exhibited will be announced later. An interesting departure is under consideration by the British Fur Breeders' Association, which is concerned with the production of fur-bearing animals apart from rabbits and silver foxes. It is hoped to include in the exhibition such animals as mink, muskrat, skunk and marten, with a view to interesting the public in the breeding of these animals in England. Important developments are reported from the United States, Canada and other countries. A substantial grant has been made by the United States government, and the general committee, under the chairmanship of Dr. Morley Jull, chief poultry husbandman, is occupied with the work of organization along with 12 subcommittees. In Canada the National Committee is under the honorary chairmanship of Dr. W. R. Motherwell, Minister of Agriculture, and includes all the ministers of agriculture of the Canadian provinces. At least 1,000 delegates are expected from the United States and Canada, and a steamship has been chartered for their transport. The German National Committee has applied for 1,500 feet of floor space, Holland will have a space at least as large, and France, Spain, Belgium and Denmark are among the other countries which will have important national exhibits.

Industrial and Engineering Chemistry reports that the College of Doctors of the University District of Barcelona, Spain, has organized an International Committee of Cultural Relations which, under an honorary committee, is composed of representatives of the university, of the College of Doctors and of the Consular Corps. The members of the governing body of this committee are one professor and one collegiate doctor for each of the five university faculties—namely, philosophy and letters, law, science, medicine, and pharmacy. The purposes for which the above committee has been organized are broad and include the cultivation of cultural relations with foreign countries, cooperation in all legitimate enterprises which tend to strengthen international relations and to guarantee the peace of the world, to encourage the study of Spanish and culture in universities and other scientific centers abroad and to endeavor to have established in Barcelona institutes representative of the culture of the various countries which will aid in making this culture known to Spain. The committee has been organized in view of the International Exposition of Barcelona, and will initiate its work by offering information and guidance to those visitors particularly interested in science, enabling them to become acquainted with the cultural centers of their city and will assist them in arranging conferences and other meetings pertinent to the occasion. The committee proposes to organize a general register of national and foreign cultural institutions, to invite the representatives of various scientific and cultural organizations to hold conventions in Barcelona, aiding them in every way possible in this connection. Further, the committee proposes to correlate the various institutions of Spanish culture throughout the world, seeking to encourage them in their work and to assist in the publication of their articles.

Albert College, at Glasnevin, Ireland, with which is combined the Free State's agricultural experiment station, has been handed over to Dublin University as a step in the government's efforts to promote the use of modern farming methods. The transfer was arranged by Patrick Hogan, Minister for Agriculture. The college and experiment farm will be administered through the newly formed agricultural department of Dublin University. It consists of approximately 350 acres of land, of which 40 per cent. is under tillage. It was organized in 1926 for the purpose of demonstrating practical farming methods, carrying out research work and disseminating a knowledge of farm management, including the commercial aspect of Irish agriculture. The buildings have been remodeled recently to provide facilities for research. The central building provides residential accommodations for about fifty students and a house staff. It includes a large refectory, lecture halls, a library well stocked with the most up-to-date works and laboratories for agricultural chemistry. A new wing has been added to the main block to provide laboratories for plant pathology, agricultural bacteriology, botany and zoology.

One of the objects of the British Science Guild, founded twenty-three years ago by the late Sir Norman Lockyer, is to educate public opinion by spreading the knowledge of scientific achievements and the results of scientific contemplation. With the view of furthering this particular aim, there was recently instituted the Norman Lockyer Lecture, and the fourth of this annual series of these lectures was delivered in London by Professor J. Arthur Thomson, of the University of Aberdeen. The subject of the address was "The Cultural Value of Natural History." According to *Nature* seven contributions of natural history to human culture were reviewed by Professor Thomson. Power is added to our vision of the world —"the eye sees what it brings with it the power of seeing; and well-informed vision is richest and clearest." The esthetic sense is cultivated—"there is no risk of the cold light of science hurting the esthetic emotion, for the more we know of a beautiful thing the greater is our enjoyment." Interest is stimulated —"natural history gives us glimpses of a dramatic world." Big ideas, such as evolution and the interrelations of living things of world-wide significance, are its progeny. Its problems present infinite variety of mental discipline and resolute thinking; and the deep impressions made by even superficial contact with nature are of fundamental value in moulding outlook. Finally, there is guidance in human affairs to be found in a rational study of animate nature—"a society that dispenses with sifting is working its own doom"; "success attends the small families among animals well-equipped in body and mind"; "in bygone days we heard much about original sin, we need to hear more about original righteousness," and so on. This address has been printed by the British Science Guild and may be obtained from the offices, 6 John Street, Adelphi, W.C.2. The Guild requires financial support to enable it to carry on and extend its useful work for the public good, and an appeal is made for new members.

UNIVERSITY AND EDUCATIONAL NOTES

Nature reports that the new laboratory at the University of Sheffield for research on the cold-working of steel, opened on July 6, has been established in consequence of a gift from the Worshipful Company of Ironmongers of London, which made a grant of £800 a year for seven years to endow a fellowship and two scholarships in the cold-working of steel. To make this gift available, the firms connected with the cold-working industry have, through the Cutlers' Company of Hallamshire, presented the university with the necessary plant.

Professor R. D. Carmichael has been appointed administrative head of the department of mathematics at the University of Illinois as successor to Professor E. J. Townsend, who was granted his own request to be allowed to retire on September 1 of the present year.

At the University of Chicago, Dr. Samuel K. Allison, of the University of California, has been appointed associate professor of physics. Dr. I. S. Falk, hygiene and bacteriology; Dr. G. K. K. Link, botany, and Dr. Sewall Wright, zoology, have been promoted to full professorships.

Dr. Harold St. John, associate professor of botany and curator of the herbarium at the State College of Washington, has been appointed professor of botany at the University of Hawaii and on the botanical staff of the B. P. Bishop Museum. Otis W. Barrett, agricultural director of the Insular Department of Agriculture and Labor of Porto Rico since 1923, has been appointed to the chair of horticulture.

At the University of South Carolina, Dr. W. E. Hoy, Jr., has been appointed professor of biology and head of the department, and Dr. J. T. Penney associate professor of zoology.

Professor W. E. Milne, of the University of Oregon, who has been on leave as professor of mathematics at Stanford University this year, will return

to the University of Oregon next fall. During his absence Dr. H. C. Hicks has served as assistant professor of mathematics at the University of Oregon. Dr. Hicks has recently been elected professor of mathematics and aeronautics at Texas Technological College.

R. A. ROBERTSON, reader in botany in the United College, St. Andrews, has been appointed to the newly established chair of botany in the University of St. Andrews, which places him at the head of the departments of botany in the United College, St. Andrews, and in University College, Dundee.

DISCUSSION

ATMOSPHERIC ELECTRICITY DURING SAND STORMS[1]

THE observations of Canfield[2] that sand storms cause atmospheric electrical disturbances and that during the storm an arc will pass between the points of an aerial wire and a ground wire may be explained as analogous to the "Dorn effect"[3] in liquid systems.

Colloid chemists have recently devoted considerable attention to methods for the study of the electrokinetic potential, *i.e.,* the absolute magnitude of the electrical charge on the surface of colloid particles. The methods usually employed are cataphoresis or electroendosmosis. Cataphoresis is the migration of a suspended particle through a liquid under an impressed electrical potential, the particle migrating toward the electrode having the opposite sign to the electrical charge on the particle. The rate of migration under a constant electrical potential is proportional to the magnitude of the electrokinetic potential on the surface of the particle, or

$$\zeta = \frac{4\pi V \eta}{E \varepsilon} \qquad (1)$$

where ζ = the electrokinetic potential; V = the velocity of migration; η = the viscosity of the medium; E = the applied E.M.F. per unit length between electrodes, and ε = the dielectric constant of the medium.

Electroendosmosis is similar to cataphoresis except that in this instance the material under investigation is a gel or a porous membrane. When the pores of such a membrane are filled with liquid and electrodes are inserted in the liquid on opposite sides of the membrane, a streaming of liquid takes place through the membrane toward the electrode having the same sign as the charge on the surface of the membrane. The rate of flow of liquid through the pores of the membrane under a constant electrical potential is proportional to the magnitude of the electrokinetic potential on the surfaces of the capillaries, or for a bundle of capillaries of cross-section q,

$$\zeta = \frac{4\pi v \eta l}{q H \varepsilon} \qquad (2)$$

where v = the volume of liquid transported in unit time and l = the length of the capillaries, the other quantities having the same values as in equation (1).

The streaming potential is the converse of electroendosmosis and has been studied by Freundlich,[4] Kruyt[5] and Briggs.[6] It must be obvious that if an electrical potential produces streaming through a membrane, then streaming a liquid through a membrane by hydrostatic pressure will set up an electrical potential difference between electrodes immersed in the liquid on the opposite sides of the membrane. This potential difference may be of considerable magnitude. Thus, Martin[7] has observed a potential difference in excess of 1.25 volts when nitrobenzene was streamed through a cellulose membrane under a hydrostatic pressure of approximately 19 cm of mercury.

The electrokinetic potential at the interface of such a system may be calculated by the formula,

$$\zeta = \frac{4\pi \eta \varkappa_s H}{P \varepsilon} \qquad (3)$$

or

$$H = \frac{\zeta P \varepsilon}{4\pi \eta \varkappa_s} \qquad (4)$$

where $\varkappa_s$ = the specific electrical conductivity of the liquid as it exists in the pores of the diaphragm; H = the E.M.F. developed between the electrodes, due to the streaming of the liquid, and P = the hydrostatic pressure under which the liquid flows through the diaphragm, the other quantities being as in equations (1) and (2).

The Dorn effect is the converse of cataphoresis, *i.e.,* if an electrical potential gradient will cause the movement of charged particles through a medium, then the movement of charged particles will set up an

[1] Published with the approval of the director as Paper No. 870, Journal Series, Minnesota Agricultural Experiment Station.

[2] R. H. Canfield, SCIENCE, 69: 474–475, 1929.

[3] E. Dorn, *Ann. Physik.,* 5: 20–44, 1878; 9: 513–552, 1880; 10: 46–76, 1880.

[4] Freundlich and Rona, *Sitzber., preuss. Akad. Wiss.,* 20: 397–402, 1920.

[5] H. R. Kruyt, *Koll. Z.,* 22: 81–98, 1918; 45: 307–319, 1928.

[6] D. R. Briggs, *J. Phys. Chem.,* 32: 641–675, 1646–1662, 1928; *J. Am. Chem. Soc.,* 50: 2358–2363, 1928.

[7] W. McK. Martin, unpublished data taken from Ph.D. thesis filed in Library of the University of Minnesota, June, 1929.

electrical potential. Those systems which have been somewhat studied have all been solid-liquid systems in which the particles were allowed to fall through the liquid under the force of gravity. This is true of Dorn's original observations, as well as the later work of Stock,[8] who obtained "sedimentation potentials" of the order of 80 volts, when quartz powder was allowed to fall through a 2-meter column of toluol. No formula has as yet been devised whereby the ζ-potential can be calculated from the observed and measured "sedimentation potential" difference which exists across the electrodes. A study designed to develop a correct formula is already in progress in our laboratories.

From the foregoing there can be but little doubt but that the "atmospheric electricity" effects observed by Canfield during the sand storms are analogous to the sedimentation potential observed in liquid-solid systems. In the sand storms the force moving the particle is the wind instead of gravity, the viscosity of the air is much lower than that of a liquid system ($\eta = ca.\ 1900 \times 10^{-7}$ at 20°), the specific conductivity of dry air is extremely low, the dielectric constant of air is low (*ca.* 1.0), so that if a formula similar to (4) should hold, the system is such as to favor the production of high potentials, the magnitude of the potential which is developed being influenced by the force of the wind (P) and the magnitude of the electrokinetic potential (ζ) on the surface of the sand particles. Of course, relative humidity will be a factor, since this would affect the dielectric constant, the viscosity and the conductivity of the air.

It is surprising that this source of "atmospheric electricity" has not been earlier recognized. Falling rain drops or the rapid motion of any charged particles through any medium which is a poor conductor of electricity should produce this effect. Probably the "static electricity" which occasionally causes explosions in sugar refineries, flour mills, starch factories, etc., may result from similar causes, for a relatively high electrical potential should be generated whenever dry powders are allowed to flow at high velocity through dry air.

Ross Aiken Gortner

University of Minnesota

WRECK OF THE ARCHEOLOGICAL DEPARTMENT OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

The sale of the Clarence B. Moore collection by the trustees of the Academy of Natural Sciences of Philadelphia and the concomitant destruction of the academy's archeological department call for explanation. The Clarence B. Moore collection is the finest, most comprehensive and best documented assemblage of Indian antiquities from the mounds and cemeteries of the southern states. It is now in the possession of the Museum of the American Indian, Heye Foundation, of New York City.

The facts, as far as known, are these.

On December 1, 1928, it was announced that Mr. Charles M. B. Cadwalader, a trustee of the academy, had been made managing director of the academy—an office not created until new by-laws were passed on January 15, 1929. The managing director was without museum experience, and his first official inspection of the archeological department revealed him as ignorant of the value and importance of its collections. He summoned Mr. Moore to a conference, ostensibly to discuss the cleaning of his cases, which, according to his contract with the academy, were not to be opened in his absence. Owing to his departure for Florida, Mr. Moore was unable to meet Mr. Cadwalader.

Some weeks later, the managing director began inquiries as to the donors of the academy's archeological and ethnological collections—their residence, if living, their heirs, if dead.

On February 28, notice was served to the scientific staff that the academy's stock of publications was being moved to the top of the book-stack—one hundred copies of each part of the "Proceedings" and seventy-five of each part of the *Journal*—and the remaining "surplus stock," amounting to several tons, would be destroyed.

The editor, Mr. W. J. Fox, called Mr. Cadwalader's attention to the fact that Mr. Moore's "Reports," making twenty issues of the *Journal,* had been paid for entirely by Mr. Moore. To this, Mr. Cadwalader replied: "Mr. Moore is in Florida and we can not reach him. We will say nothing about it." At Mr. Fox's suggestion, the present writer sent Mr. Moore an offer of as many sets of his "Reports" as he should wish to request. To this, Mr. Cadwalader later agreed.

The "surplus stock" of the academy's publications was saved from burning or defacement only by the protest of the united scientific staff, and they are being sent out to scientific institutions.

In March, the entire east end of the archeological hall was ordered cleared. Archeological and ethnographic material from thirty cases was sent to storage in the rather leaky old museum. This was to make space for proposed groups of sheep and goats. At this time, the managing director stated that the entire archeological hall would be used for mammal groups and that no other exhibition space would be provided

[8] M. J. Stock, *Bull. intern. acad. sci. Cracovie,* 1913, p. 131; *Anzeiger Akad. Wiss. Krakau* (A), 1914, p. 95–106.

for the archeological department, unless money were procured for it. The assistant curator called his attention to the half million dollar bequest that had come with the R. H. Lamborn Mexican archeological collection.

Early in April, the managing director came to the assistant curator in charge of the department, questioning as to the catalogs, the labels, the relative size of collections, the existence of other archeological collections anywhere on the premises, and ended by ordering the catalogs brought to his office that he might "familiarize himself with them." There they remained for about a week.

On April 17, Mr. Moore returned from Florida, and, at Mr. Cadwalader's urgent request, came on the following day to a consultation at the academy. Before going to the director's office, he asked the assistant curator to show him what had been done with the Vaux archeological collection and the other material—chiefly Haldeman and Gottschall—which had been sent to storage. His comments were brief and bitter.

On Monday, April 29, the assistant curator was summoned to the museum to "tell Mr. Heye what is under Mr. Moore's cases." He was found, notebook in hand, among the cases of ethnographic material, and his questions related as much to these as to Mr. Moore's. His mover was with him.

A flying line of inquiry to Mr. Moore brought the following reply:

> Yes, Mr. Heye has the Moore collection.
>
> Of course, I regret the transfer of my collection to New York, the fruit of thirty years' hard work of Dr. Miller and myself and very heavy expense.
>
> The academy is now wholly devoted to the lower animals and the floor on which the archeological specimens were is needed for natural history groups. The Vaux archeological collection, after the death of Mr. Vaux, the trustee, was moved out and I felt confident that, at once, after my death my collection would go to undesirable quarters, perhaps even into storage.
>
> As it is, my collection goes to a museum wholly devoted to archeology and ethnology of the American Indian, where it will be properly displayed and cared for. I regret to see it leave the city, but it is Hobson's choice.

Meanwhile, the assistant curator went on Tuesday to Mr. Cadwalader with the query: "Are the cases included in the sale of the Moore collection?" Beneath them was stored the famous Morton collection of crania, and provision would have to be made for its care.

He demanded: "Who told you the Moore collection was sold?"

"I had it from Mr. Heye."

"You were not supposed to talk to Mr. Heye.—Mr. Heye was not supposed to say anything about it.—Yes, the Moore collection has been sold, and with it goes all the American Indian stuff, North American, South American and Central American: that means all the Haldeman collection, all the Gottschall collection, all the Peary collection—everything that is not bound by the terms of gift. I do not know what we shall do with the Morton collection—Mr. Heye does not want it.—The catalogs are to be sent along, that Mr. Heye may get what information there is in them. Mr. Heye's trucks will be here next Monday morning. They will drive into the interior court and load there, directly from the museum.—Furthermore, there is to be no publicity—no talk either inside or outside the academy."

To the assistant curator's reply asserting freedom outside the academy to do what was deemed right, the alternative was given: silence or immediate dismissal.

The week was spent by the assistant curator in saving the collection of the American Philosophical Society, deposited in 1879, and intercalated with the academy's series.

On Friday, one of the trustees returned to Philadelphia, and was astonished to learn, from one of the attachés, of the sale, of which he knew nothing. A second trustee was found to be also unaware of the transaction.

The managing director, although visitors commented to him on the Moore collection, kept silence as to the sale, yet, by some channel unknown to the present writer, it was already rumored in Washington.

No other institution in Philadelphia with kindred interests had been informed of the proposed sale or given an opportunity to bid upon the material. The management of one such made efforts to save the collection for Philadelphia, after learning unofficially of the impending removal, but without success.

On Monday morning, May 6, Mr. Heye's representative took possession. The stripping of the hall proceeded rapidly and efficiently, with so large a corps of packers that it was impossible to oversee them and make sure that nothing went that should not. The Lamborn collection of Mexican antiquities was carried off to New York, although it had been expressly designated by the managing director as withheld from the transfer, so acknowledged by Mr. Heye's representative, and marked to remain by the assistant curator.

At noon on Tuesday, as a last resort, the assistant curator went to the president, Mr. Effingham B. Morris, and implored him for the honor of the academy and the honor of the city, to save these collections. Mr. Morris believed that Mr. Moore

wished his collection sold to the Museum of the American Indian, Heye Foundation. He had no idea of the number and importance of specimens in the other collections involved, referring the matter back to the managing director. One statement came out clearly, for the first time: "Only the Moore collection had been sold." The Gottschall collection of nearly five thousand pieces, valued by its donor at about $50,000, the Haldeman, older and larger, and all the smaller series, containing objects of the rarest sort—perhaps twenty thousand specimens in all—were said to be sent along as of no importance.

The warning that, if this were not stopped, it would be "the greatest scandal there has ever been in the history of American archeology and ethnology" had no effect, and no alternative was left the assistant curator but to hand Mr. Morris her resignation.

May 6, 1929

Board of Trustees,

The Academy of Natural Sciences of Philadelphia.

Gentlemen:

I hereby tender my resignation as Assistant Curator in Charge of the Department of Archeology. It is with deep regret that I sever a connection extending into the thirtieth year, but the sale of all the American Indian archeological and ethnological collections of the Academy to the Museum of the American Indian, Heye Foundation of New York City, without the knowledge of all your Board, and certainly without full understanding of what the loss of these priceless collections will mean to the prestige of the Academy and the honor of our city, constitutes, in my opinion, a breach of faith with the past and a menace to the future of the great collections of all the departments of the Academy.

I hereby register my protest against this blanket-sale, secretly negotiated, and the proposed clandestine removal, without adequate time given for the security of deposited collections not the property of the Academy.

Respectfully,

(Signed) H. Newell Wardle

Presumably, urged by public and private protest which followed this disclosure of the sale of the Indian collections, the managing director and the academy's solicitor went to New York, on May 9, and the press was requested to await an announcement. That announcement, published on the eleventh, was to the effect that the collections, other than Mr. Moore's, had "been merely loaned on the usual terms for study." This was the first intimation of a loan, which, whatever its terms, did not conform to custom.

It is said, on good authority, that, when the Heye Foundation thus lost permanent title to these unconsidered trifles, the academy's officials had to surrender a part of the ten thousand dollars received for the Moore collection.

Two truck-loads of specimens were returned to the academy, May 17 to 21, and were piled, loose, unpacked, indiscriminately, on the floor of the old museum.

A letter by the present writer addressed to the trustees and protesting against such treatment of valuable material, had for result its deportation to the cellar, where it lies in a similar heap. Most of it is perishable, and will ere long become as valueless as the trustees were led to believe.

It is obvious from this sequence of events that Mr. Moore's consent to the sale of his collection, behind which the managing director has taken shelter, was not a free choice. It was the only way he saw to save his collection from such destruction as has fallen upon this returned material. He was left in ignorance even of the price the academy took for it—a price far below its marketable value, had the wish to sell been known.

The end is not yet. The affair is not only a shame to an ancient and honorable institution which in the hundred and seventeen years of its life accepted the trust of archeological and ethnological collections. If misguided trustees, chosen for their business ability to manage the financial affairs of an institution, have the power, without asking expert advice, so to wreck a scientific department, it shakes the foundations of confidence in every institution in America.

H. Newell Wardle

Sharon Hill, Pa.

THE DICTIONARY OF AMERICAN BIOGRAPHY

The following notes on the second volume of the "Dictionary of American Biography" are written, not with any desire to find fault, but rather, where a work is so good, to ask why it might not be a little better.

Human touches introduced into some of the sketches are commendable. However, the work will serve primarily a public chiefly interested in fact or judicial appraisal.

To satisfy such readers, some degree of uniformity in treatment is desirable, if for no other reason than this, that the time of the investigator is saved. The "Who's Who" method of presenting essential facts might well be considered by the editors.

It is not suggested that all such facts are of equal relevance, but surely the interest in genetics justifies the inclusion of all significant facts of inheritance. To illustrate, the reader of the sketch of Charles E. Bessey might very properly have been informed that his son, E. A. Bessey, is also a distinguished botanist.

My attention was particularly caught, in reading the sketch of B. S. Barton, by the failure to note the

reprint of his Collection towards a Materia Medica, in Lloyd's Bulletin, No. 1, in 1900. The article shows other omissions of noteworthy facts. For example, no mention is made of the honor bestowed upon Barton by Nuttall in naming a genus of plants "Bartonia." This name has been dropped, as Muhlenberg had given the name Bartonia to another genus and Nuttall's Bartonias are now Mentzelias. Barton's aid to both Pursh and Nuttall is a significant fact in the history of American botany. Barton himself took credit for the fact; see Lloyd's Bulletin, No. 1, page 3. A reference to Barton's connection with William Bartram, referred to in the article on Bartram, should certainly have been included.

A print of one portrait of Barton is mentioned, but the much more accessible reprint in *Popular Science Monthly* for 1896 (vol. 48) is not mentioned.

The bibliography is, of necessity, brief, but it might very properly have included a reference to the article in the *Popular Science Monthly,* (vol. 48: 834–40); possibly also to the reprint of the sketch of W. P. C. Barton, in his "Revised Elements of Botany," in 1836.

Some other articles in the volume are subject to similar criticism. Let this instance of Barton stand as an example. If it be urged that space is limited, it might be answered that at least the facts here mentioned are more significant than some of those included. Nothing should be omitted from the Barton sketch as it is printed, but a little condensation would have permitted the inclusion of everything here suggested.

The omission of (*q.v.*) after the name of T. P. Barton is, of course, only an oversight. Last of all, permit a query of fact: In the article on Jacob Bigelow, should it not be B. S. Barton, not W. P. C. Barton, under whom Bigelow studied?

WILLIAM H. POWERS

LIBRARY, SOUTH DAKOTA STATE COLLEGE

PROFESSOR CONN AND THE BROOKLYN INSTITUTE

IN the note in SCIENCE on the celebration of the conclusion of the first quarter century of the work of the Carnegie Institution at Cold Spring Harbor, Long Island, no mention is made of the previous work carried on there by the late Professor Conn under the auspices of the Brooklyn Institute of Arts and Sciences.

I had the very great pleasure of working under his direction there during the summer of 1892 when I was a medical student, and he showed a remarkable ability to interest his students in personal research and observation.

LOUIS C. AGER

SPECIAL CORRESPONDENCE

TESTIMONIAL DINNER TO DR. MERRILL

DR. GEORGE PERKINS MERRILL, head curator of geology in the U. S. National Museum, was tendered a dinner on Friday evening, May 31, 1929, at the Cosmos Club in Washington, by friends and colleagues from scientific circles. The dinner was given in honor of Dr. Merrill's seventy-fifth birthday.

Dr. Merrill was born at Auburn, Maine, May 31, 1854, but for half a century has been a resident of Washington where he has been connected with the Smithsonian Institution. During this time Dr. Merrill has won admiration and high esteem from his many friends and acquaintances in scientific and social spheres. His career is indicated by his versatility. He is a teacher, a critic, a public speaker, an executive and a scientist. During his long and active life, Dr. Merrill has done much for the advancement of science, among his many achievements being several works which stand out as monuments, namely, "Stones for Building and Decoration," "Rockweathering and Soils," "The First One Hundred Years of American Geology," and his many highly enlightening works on meteorites, for which, in 1922, he was awarded the J. Lawrence Smith medal by the National Academy of Sciences.

Dr. Merrill received his B.S., MS. and Ph.D. degrees at the University of Maine. In 1917 the honorary degree of doctor of science was conferred upon him by George Washington University, where he had been professor of geology and mineralogy from 1893 to 1915. He is a member of the National Academy of Sciences, Geological Society of America, Washington Academy of Sciences, American Philosophical Society, and others.

The committee on arrangements for the dinner was composed of Dr. Alexander Wetmore, chairman, Dr. Marcus Benjamin and Dr. Paul Bartsch. Dr. Charles G. Abbot, secretary of the Smithsonian, presided. The speakers of the evening were as follows.

Dr. Marcus Benjamin, editor, U. S. National Museum, gave the general report of the committee, and concluded his remarks as follows:

> In a few years the Smithsonian will celebrate its centenary, and I can not but believe that when that event occurs, there will be those who will trace the history of that great institution and who will have much to say about the work of the eminent Henry, and they will review the valuable contributions made by the distinguished Baird. Those who are living in that day will learn more

of the researches of the able and much-loved Goode, and will come a little closer to the eminent if disappointed Langley, and somewhere there will be told something of the important results achieved by Merrill, so that his name will shine with added glory among this galaxy of scientists, contributing much to his own fame and reflecting luster on the reputation of the great institution which he has served so faithfully during the many years of his long life.

Dr. L. O. Howard, formerly chief of the Bureau of Entomology, U. S. Department of Agriculture, now retired as senior entomologist, spoke of Dr. Merrill's work as a museum curator. Dr. Howard gave his address with unusual charm, and paid high tribute to Merrill's qualifications in this line, stating that "Dr. Merrill is the best museum man in his line alive to-day."

The next speaker, Dr. H. S. Washington, of the Geophysical Laboratory, Carnegie Institution of Washington, whose subject was "Dr. Merrill and his Studies of Meteorites," spoke as follows:

It was my privilege to make the acquaintance of Dr. Merrill and of the City of Washington simultaneously, about 1888, at the time when his first paper on meteorites was published. Since then he has "carried on" most actively along this line, and, apart from many books and papers dealing with other subjects, he is the author of some fifty-eight papers on meteorites alone, in which he describes forty new falls—a truly remarkable record. And he is still going strong. He is one of the most active workers on meteorites now living, and his researches cover many different phases of their study. Dr. Merrill thus takes his place with his famous predecessors, J. Lawrence Smith and C. U. Shepard, as one of a great trio high in the annals of American science.

In a long series of memoirs and papers on the chemistry of meteorites, Dr. Merrill, with the analytical cooperation of Dr. J. E. Whitfield, has made one of the most valuable contributions of recent years to our knowledge of these bodies. In the course of these he showed the general presence of certain elements (such as those of the platinum group) and the absence of others (as barium and fluorine). Merrill has also made many detailed studies of the various minerals that occur in meteorites, adding much to our knowledge of them. One of these, first identified by him, has been named in his honor. He has also devoted much attention to the study of the peculiar textures of meteorites, casting light on some hitherto obscure features. For these researches Dr. Merrill was awarded the J. Lawrence Smith gold medal by the National Academy.

Our friend also contributed greatly to the elucidation of the vast "crater" in Arizona, known as Meteor Crater, as having been caused by the impact of a huge meteorite, thus disposing of the hypothesis that it originated in the strenuous efforts made by a Scotchman to recover a shilling that he had lost down a gopher hole.

For these researches he had the courage to make use of the meteorites in his care in amounts sufficiently large for the scientific purpose in view. Similarly, many mineralogists are deeply indebted to him for his generosity and broadmindedness in providing material and specimens of minerals for proper scientific study. The specimens were not used up—they were rightfully used. In this respect Dr. Merrill stands out from many museum curators, who regard specimens only as objects to be viewed in a glass case, rather than as material for scientific study. He is thus, to my mind, an ideal type of curator.

Finally, Dr. Merrill, by his industry, wisdom, the ability to make friends and the knowledge that specimens entrusted to him will be fully appreciated and properly used for their scientific interest, has got together, in the forty-odd years of his curatorship, a magnificent collection of meteorites in our National Museum. It is one of the great meteorite collections of the world, and it, with his many contributions to the science of these mysterious bodies, will always remain one of his greatest memorials.

Dr. Harvey W. Wiley, well known in the field of chemistry, then had a word to say as to Dr. Merrill's chemical researches in geology. "Dr. Merrill is the most complete authority on soils," said Dr. Wiley. "He has given much to geology but has given much more to agriculture—how much, the public will never know." Dr. Wiley further stated, "The greatest work on the genesis of soils we owe to Merrill."

Miss Margaret W. Moodey, Dr. Merrill's assistant for many years, then presented a bound volume of testimonial letters of congratulation and esteem, from his friends and colleagues in America and foreign countries.

Dr. Merrill's response followed. He said, in part: "At times I have felt that I must get away from Washington, but after talking the matter over with Mrs. Merrill, we decided to stay. To-night I am happy that we did, for in no other place could we have found the culture and friendship that we have here." Dr. Merrill closed his address with lines expressive of a hope based upon T. B. Brown's well-known poem:

"I stand upon the summit of my years!"
So may it ever be,
Not bowed beneath their weight
With feet firm planted
And soul undaunted
I'll stand and contemplate
What time has wrought,
And tremble not
For what was, is,
Or is to be,
I'll stand upon the summit of my years.

James H. Benn
U. S. National Museum

REPORTS

FOREIGN RELATIONS OF THE NATIONAL ACADEMY OF SCIENCES

THIS report for the year 1928–29 is, as usual, the report of one of your officers in his dual capacity as foreign secretary of the academy and chairman of the division of foreign relations of the National Research Council. The activities of the past year may be summarized as follows:

1. The sections of the academy have been canvassed for suggestions as to nominations of foreign associates, and five new foreign associates have been nominated. If these are all elected the total number of foreign associates will be 47, which lacks but 3 of the constitutional limit. Of these, 8 are in mathematics, 6 in astronomy, 7 in physics, 3 in engineering, 3 in chemistry, 6 in geology, 4 in botany, 5 in physiology and pathology, 4 in zoology and anatomy and 1 in anthropology and psychology.

2. Arrangements have been completed for the joint participation of the French Academy, the Royal Society of Great Britain and the National Academy in the establishment of the Charles Doolittle Walcott medal and in the selection of medalists.

3. A large amount of correspondences and committee action has been carried on from the office of the secretary of the division of foreign relations of the National Research Council in connection with the participation of the United States in the Fourth Pacific Science Congress to be held in Batavia and Bandoeng, Java, between May 16 and 24. Twenty-seven representative American scientists are now voyaging over the Pacific to this congress.

4. Arrangements have been made for American participation in the fifteenth International Geological Congress to be held in Pretoria, South Africa, between July 29 and August 7. Eight American geologists have been appointed as delegates and other geologists from this country are also planning to attend the congress, bringing the total number of American participants in the congress up to fifteen. Plans have been initiated for holding the sixteenth International Geological Congress in the United States in 1932.

5. Arrangements have been made for the representation of the United States in the International Congress of Oceanography and Marine Hydrography and Continental Hydrology, which will be held between May 1 and 6 in Seville, Spain, in connection with the Ibero-American Exposition. Mr. George W. Littlehales has been named as the representative from the National Research Council and the National Academy at this congress.

6. Because of the relationships of the academy to the government on the basis of its congressional charter, the officers of the division of foreign relations of the Research Council and the officers of the academy have been able to arrange for the payment of the dues of the various unions, to which the Research Council has adhered, through congressional appropriation. The total amount which has been appropriated for this purpose for the current year (1928–29) was \$4,480, but on account of recent changes in the dues and in the value of the franc the National Research Council has been obliged to make a supplementary appropriation for the payment of these dues to the amount of about \$1,348.70, thus bringing the total sum appropriated by the government, together with the appropriation from the Research Council, for the payment of American dues in international scientific unions up to about \$5,800. It is hoped and expected that in future these dues will be wholly met by the government appropriation. This very substantial assistance to American science on the part of the government is made possible solely through the academy's official status. The unions sharing in the foregoing advantages are:

International Astronomical Union
International Geodetic and Geophysical Union
International Union of Pure and Applied Chemistry
International Mathematical Union
International Union of Pure and Applied Physics
International Union of Radio Telegraphy
International Geographical Union.

7. Through the division of foreign relations of the National Research Council, American opinion has been obtained and a set of specific proposals formulated with respect to a modification of the statutes of the International Research Council. At the general assembly of this body held in Brussels on July 13, 1928, a committee of fifteen members was appointed and charged with the task of formulating proposals for such a modification. Sir Henry Lyons, of the Royal Society, is secretary of this committee and Dr. Frank Schlesinger, director of the Yale University Observatory, and Dr. Vernon Kellogg, permanent secretary of the National Research Council, are its American members.

The division of foreign relations after prolonged discussion has adopted and transmitted to this committee for its information and guidance a definite set of recommendations embodying, in so far as the division of foreign relations has been able to obtain and express it, current American opinion. The full text of these recommendations is contained in the report of the division of foreign relations on file in the office of the National Research Council. Mimeographed copies of this report have been distributed to academy members.

The most significant recommendations of this report are contained in the following paragraphs quoted from this statement:

1. That the International Research Council should be continued.

2. That the statutes of the International Research Council should be entirely rewritten rather than merely amended in certain respects.

3. That in rewriting these statutes the committee on revision of the statutes shall call into conference for advisory purposes representative scientists of countries not now adhering to the International Research Council.

4. That it would be desirable that the new organization be known not as the International Research Council but as the International Federation of Scientific Unions.

R. A. MILLIKAN,
Foreign Secretary of the National Academy of Sciences

APRIL, 1929

SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPARATUS FOR THE DETERMINATION OF CARBON DIOXIDE IN THE RESPIRATION OF APPLES

A REVIEW of the various methods adopted for the determination of the rate of respiration in apples as measured by carbon dioxide evolution discloses the fact that most investigations involve rather small quantities of the product used. When the amount of fruit used is not over three to four kilograms (twenty to thirty apples) it is almost impossible to avoid high experimental error, due largely to the variation in maturity of individual fruits. Recent investigations by Kidd and West[1, 2] show a wide variation in respiratory activity of single apples taken from the same sample. By the use of the pickle-bottle respiration chamber[3] in which eight to nine kilograms of fruit (sixty-five to seventy apples) of approximately one half of a standard apple box in size were used, a method of carbon dioxide determination was devised which was efficient and sufficiently unique in its adaptation to warrant a brief description.

DETAILS OF THE APPARATUS

The apparatus used for the determination of carbon dioxide as a measure of respiration is shown in Plate 1. Air was drawn through two wash-bottles, 1 and 2, containing 50 per cent. potassium hydroxide. It was then bubbled through Ba $(OH)_2$, 3, as a check for small amounts of carbon dioxide. Connections with the respiration chamber, 4, were made with copper tubing in such a way as to draw the carbon dioxide-laden air from the bottom of the bottle. At the points B and C, "Y" tubes were placed in order that the air-stream might be directed either through the absorption tower for the measurement of carbon dioxide or directly to the flow-meter in case continuous aspiration was desired without measuring the carbon dioxide. A simple manipulation of the steel clamps permitted the air to pass through either system.

This system was further desirable because it made possible the removal of carbon dioxide which might have accumulated in the respiration chamber previous to a determination. By this means it was also possible to make connections with the absorption tower with only a momentary stoppage of the air-stream. Where total carbon dioxide was desired, two absorption towers were used, and at the end of one determination the air current was directed through the second tower, through connections previously made. By this method, continuous aspiration was practically accomplished with no loss and very little accumulation of carbon dioxide in the respiration chamber.

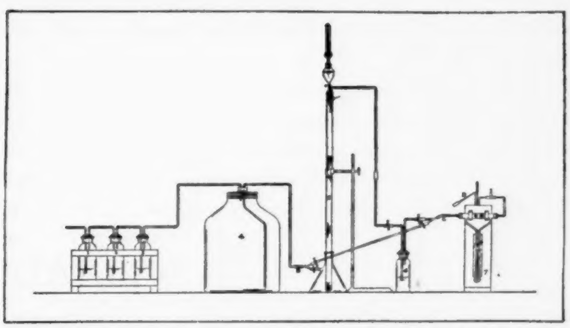

Plate I. Apparatus for the determination of CO_2 as a measure of respiration.

Carbon dioxide was absorbed in a Truog Absorption Tower,[4] 5. Bottle No. 6 contained barium hydroxide and served to indicate whether carbon dioxide was passing off unabsorbed. A flow-meter, 7, was

[1] Franklin Kidd and Cyril West, "The Storage Life of Apples in Relation to Respiratory Activity and Chemical Composition," Report Food Investigation Board, pp. 37–57, 1925–1926.

[2] Franklin Kidd and Cyril West, "Fruit and Vegetables," Report Food Investigation Board, Section B, pp. 23–27, 1927.

[3] T. J. Maney, P. L. Harding and H. H. Plagge, "A New Type of Respiration Chamber," SCIENCE, 70, p. 44, 1929.

[4] E. Truog, *Journal of Industrial and Engineering Chemistry*, Vol. 7, No. 12, p. 1045. Dec., 1915.

adapted to this apparatus in order to keep the rate of aspiration uniform and of a known velocity. The flow-meter was connected with the aspirator at the point "D."

Reagents Used

Standard Hydrochloric Acid Solution........ 0.2 N.
Standard Barium Hydroxide Solution........ 0.2 N.
Phenolphthalein as Indicator.

In order to give an idea of the suitability of this apparatus for respiration studies the following data, which were obtained as the result of five consecutive determinations, each of one hour duration, are presented.

Type of sample	Determination	No. of apples	Wt. of sample	Storage temp.	Mg. CO_2 per kilo. hour
Grimes Golden apples	1	70	8659 gm.	30° F.	3.31
"	2	"	"	"	3.65
"	3	"	"	"	3.62
"	4	"	"	"	3.62
"	5	"	"	"	3.62

SUMMARY

A respiration chamber of low original cost was used, which because of its large size was adapted to handling samples of considerable bulk or quantity. The most important feature of the chamber was its wide mouth, which permitted easy insertion and removal of samples.

With the double system of connections, either total or intermittent determinations were made with only momentary stoppage of the air-stream.

The flow-meter proved very satisfactory in maintaining a known and uniform rate of aeration.

The apparatus described was admirably adapted to the determination of carbon dioxide as a measure of respiration on apples, tomatoes and cut flowers.

P. L. HARDING
T. J. MANEY
H. H. PLAGGE

IOWA STATE COLLEGE

APPLE RUST ON HOST TISSUE IN CULTURE DISHES

YOUNG York Imperial apple leaves were removed from the tree, washed, treated with 1–1,000 bichloride of mercury for about two minutes, rinsed in sterile water and inoculated with sporidia of *Gymnosporangium juniperi virginianae*. Inoculation was accomplished by placing a large culture dish containing several leaves under a bell-jar in which was suspended a rust gall discharging sporidia. The leaves were allowed to remain there for about one to two minutes and were then placed in culture dishes containing modified Pfeffer's solution plus .5 per cent. glucose. The cultures were placed in a well-lighted room. Such inoculated leaves developed visible rust spots and pycnia in approximately the same period of time which would have been required if infection had taken place in leaves on the tree. The leaves were frequently transferred to fresh nutrient solution. Cutting away large portions of the leaf did not interfere with development of the disease in the remaining portions. Some specimens were maintained in culture for nearly five months without evidence of deterioration. Pycnospores were produced in great abundance, and one apparently normal aecium was formed, but it was accidentally destroyed without being examined to determine if spores were present. A special type of culture dish has been devised which should enable us to carry the cultures free from contamination for a longer period of time.

N. J. GIDDINGS,
L. H. LEONIAN

WEST VIRGINIA UNIVERSITY

SPECIAL ARTICLES

NORMAL MUSHROOMS FROM ARTIFICIAL MANURE

DURING the past fifteen years there has been in the United States a remarkable expansion of the business of growing mushrooms. According to the present practice, the growers must rely entirely on composted horse manure for making their beds. The industry consumes at least 150,000 tons of horse manure annually, and is still developing rapidly, while the horse is little more than holding his own. In view of these conditions, it is evident that the mushroom growers in the near future must have a substitute or supplement for horse manure. Several growers have succeeded in supplementing their manure to a certain extent by adding straw to the compost heaps, and a few have been experimenting with artificial compost. But it is apparent that there is a need for a further systematic search for material other than horse manure which is suitable for mushroom culture. To the writer, a straw compost made according to the principles laid down by Hutchinson and Richards[1] seemed to be a good starting-point. Therefore, in the summer and fall of 1928, several compost heaps were made

[1] This is now a patented process. It was originally published as follows: H. B. Hutchinson and E. H. Richards, "Artificial Farmyard Manure," *Journ. Minn. Agr. Great Britain*, 28: 398–411. 1921–1923.

up and used for growing mushrooms on shelf beds in a room which was equipped to simulate conditions in a standard mushroom house. Four tons of wheat straw were used in making the compost. It was divided into sixteen small heaps which were treated in duplicate in eight different ways. The chemicals used per thousand pounds of dry straw were as follows: (1) 25 lbs. ammonium sulphate, 25 lbs. ground limestone and 7 lbs. acid phosphate; (2) 40 lbs. ammonium sulphate, 50 lbs. ground limestone and 7 lbs. acid phosphate; (3) 25 lbs. ammonium sulphate, 50 lbs. ground limestone and 7 lbs. acid phosphate; (4) 25 lbs. ammonium sulphate and 50 lbs. ground limestone; (5) 10 lbs. urea and 7 lbs. acid phosphate; (6) 15 lbs. urea and 7 lbs. acid phosphate; (7) 10 lbs. urea alone; (8) 75 lbs. Adco. The small heaps of straw were built up in one-foot layers and the chemicals were scattered between the layers. The heaps were systematically replicated and packed side by side into one large rick about four feet high, eighteen feet wide and fifty feet long. This rick was wet down and composted in much the same way as horse manure is composted for mushroom culture. It was surprisingly easy to keep the small heaps separate in the larger rick. The compost heated and was turned, watered and aerated five times at weekly intervals. At the time of the second turning a two-inch layer of soil was mixed into the rick. When the material seemed suitable, that is when it resembled mushroom compost in physical texture, it was placed in standard mushroom shelf beds eight inches deep. A pair of beds containing ten square feet of surface was made from each small heap, thirty-two experimental beds in all. These beds were spawned uniformly with cultures of *Agaricus campestris* L. and *Agaricus brunescens* Pk.,[2] which are known to the trade as the "Snow white" and "Brown" varieties. They were then cased and given approximately the same care that beds would receive in a commercial mushroom house. Notes were taken on: the temperature of each heap during fermentation, the character of spawn run, pH value, moisture content and degree of decomposition of the compost in each heap, and finally the daily yield of each bed throughout the cropping period.

Normal sporophores of *Agaricus campestris* and *Agaricus brunescens* developed on all the beds; there was a normal run of mycelium in many of the beds, and, although the average yield was low, approximately one fourth pound per square foot, there were four beds (from two different compost heaps) which yielded more than two thirds of a pound per square foot. This was approximately one half of the yield of composted horse manure, which was included in the experiment as a check. The comparatively high yield obtained on these four beds was apparently not due to the specific chemicals used on the straw or to any particular care given the high yielding beds during the growing period. It seemed rather to trace back to specific conditions which developed within the small experimental heaps during the period of fermentation. The compost from duplicate experimental heaps which had received the same chemical treatment was often quite different in pH value, moisture content, degree of decomposition, ability to support a run of spawn and to produce a crop of mushrooms. This may be illustrated by the fact that the duplicate heaps corresponding to both the high yielding heaps were poor yielders. That this was not due to differences in the care given the beds in the house is indicated by the fact that in all cases the yields of duplicate beds, coming from the same experimental heap, were very nearly alike. Apparently, certain experimental heaps, in spite of similar chemical treatment and subsequent handling, attained distinct individuality while composting which made the compost either favorable or unfavorable for the growth of *Agaricus*.

Under these conditions it seems quite probable that there were differences in the microbial flora of the different experimental heaps. The effect of these differences in the flora of the compost on the growth of *Agaricus* in the beds is problematic but it is a factor which deserves serious consideration. Certain observations also suggest that the microbial flora in all the artificial compost made in these experiments was quite different from that in compost heaps which mushroom growers make from horse manure. In the first place, the artificial compost as a rule did not ferment at temperatures higher than 120° F., while horse manure usually reaches temperatures of 150° F. to 160° F.; secondly, the pH value of the artificial compost varied considerably from one heap to another and in no case was it more alkaline than pH 7.2. On the other hand, when horse manure is composted for mushroom culture, it is quite uniform in reaction and normally alkaline. The courteous cooperation of several commercial mushroom growers enabled us to test more than 150 samples from twenty-eight different compost heaps. The pH values of these samples ranged from pH 7.2 to pH 8.4 with a mean value of pH 7.7. It was also shown by dilution experiments that the buffer content of the artificial compost was lower than that of composted horse manure. Evidently there was a comparatively low "alkaline reserve" in the artificial compost. This may have been

[2] These cultures were identified by C. H. Kauffman as *Psaliota campestris* and *Psaliota brunescens*. The generic name *Agaricus* is used here to conform with the usage in the U. S. Department of Agriculture.

partly responsible in a direct way for the low average yield of the artificial compost because *Agaricus* mycelium produces acid in culture, and spent beds which have borne a good crop of mushrooms are almost invariably acid.

In general, then, we have learned that under certain conditions synthetic manure will yield fair crops of normal mushrooms, and, under other conditions, practically none at all. The factors responsible for these differences are as yet obscure. For the man seeking an immediately usable substitute for horse manure in mushroom culture, the results will probably be disappointing, but they are decidedly promising to one interested in the possibility of eventually developing an artificial compost which can be used as a substitute.

Edmund B. Lambert
Bureau of Plant Industry
U. S. Department of Plant Agriculture

SEVENTH ANNUAL MEETING OF THE INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Until recently research in dentistry consisted mainly of the development of patented inventions, chiefly under commercial auspices. This research, mechanical almost exclusively and directed to immediate and obvious remedial needs, has been very desirable and useful in the attainment of its important objectives. Lately the biological aspects of dentistry, with special reference to the prevention of oral maladies, have been receiving increasing attention, and promise soon to be the major concern of research in dental schools. This significant development has been accelerated by great improvements in dental education and by the stimulating influence of the International Association for Dental Research, which, founded in New York in December, 1920, is now a federation of active sections in Ann Arbor, Boston, Chicago, Halifax, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco, Toronto and Vienna, with a total of 174 members.

The seventh general meeting of the International Association for Dental Research was held in Chicago, Illinois, on March 23 and 24, 1929, at the Dental School of Northwestern University, where every facility for the successful conduct of the meeting was provided. Forty-seven members and an equal number of visitors attended the morning and afternoon sessions each day, and thirty-six papers on research were subjected to animated and instructive discussion. Most of these papers, besides treating of general biological aspects of dentition, such as the growth of the molar teeth after eruption, by H. H. Donaldson, of Philadelphia, and the dental arches of identical twins, by Samuel Goldberg, of Chicago, described research in "medical" sciences applied to dentistry, only two having been devoted chiefly to mechanical phases of dental practice. Close correlations with medical practice were considered in papers on bone regeneration, dental infection as a factor in chronic colitis and autointoxication, influence of oral infections on conditions of the blood, paroxysmal hemoglobinuria caused by organisms in dental infection, anaphylactic response to sensitization from shallow cavities in teeth, polyarthritis and carditis secondary to oral infection, etc. Abstracts of all the papers will be published in an early issue of the *Journal of Dental Research*, the association's official medium of publication, which is now in its ninth volume.

On the evening of March 23 the members, after a dinner at the Medical and Dental Arts Building, at 185 North Wabash Ave., held there the annual business meeting, which included an address by the president, Leroy M. S. Miner, D.M.D., M.D., dean of the dental school of Harvard University; also the election of new members and officers, as follows:

New Members

Boston—Benjamin Tishler; *Chicago*—H. C. Benedict, E. P. Boulger, E. D. Coolidge, R. H. Fouser, S. D. Tylman; *Halifax*—R. J. Bean, E. G. Young; *Minneapolis*—J. T. Cohen, J. F. McClendon; *New Haven*—W. G. Downs, Jr.; *New York*—Isador Hirshfeld; *Philadelphia*—S. E. Pond; *Vienna*—Bernhard Gottlieb, Ernst Kellner, Emerich Kotanyi, Rudolf Kronfeld, Moriz Leist, A. M. Schwarz, Georg Stein, Josef Weinmann, Herman Wolf.

Officers for 1929–30

President—Arthur D. Black, Northwestern University; *President-elect*—U. G. Rickert, University of Michigan; *Vice-president*—A. E. Webster, University of Toronto; *Treasurer*—William Rice, Tufts College; *Secretary*—William J. Gies, Columbia University.

The next general meeting will probably be held in Toronto, in March, 1930.

William J. Gies,
General Secretary